VP 3.59.13.

Technische Hogeschool Delft
Afd. der Technische Natuurkunde
WERKGROEP EINDONDERZOEKEN
Archief magazijn

Ballantine

AC Voltmeters
3055A
3056A
series

VP 3.59.13.

Technische Hogeschool Delft
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WERKGROEP EINDONDERZOEKEN

INSTRUCTION MANUAL

AC Voltmeters
3055A
3056A
series

APPLICABLE TO AC VOLTMETERS
3056A beginning with Serial Number 021-

Ballantine Laboratories, Inc. • P. O. Box 97 • Boonton, New Jersey 07005 U.S.A.
Telephone: 201-335-0900 • TWX: 710-987-8380

90100985A

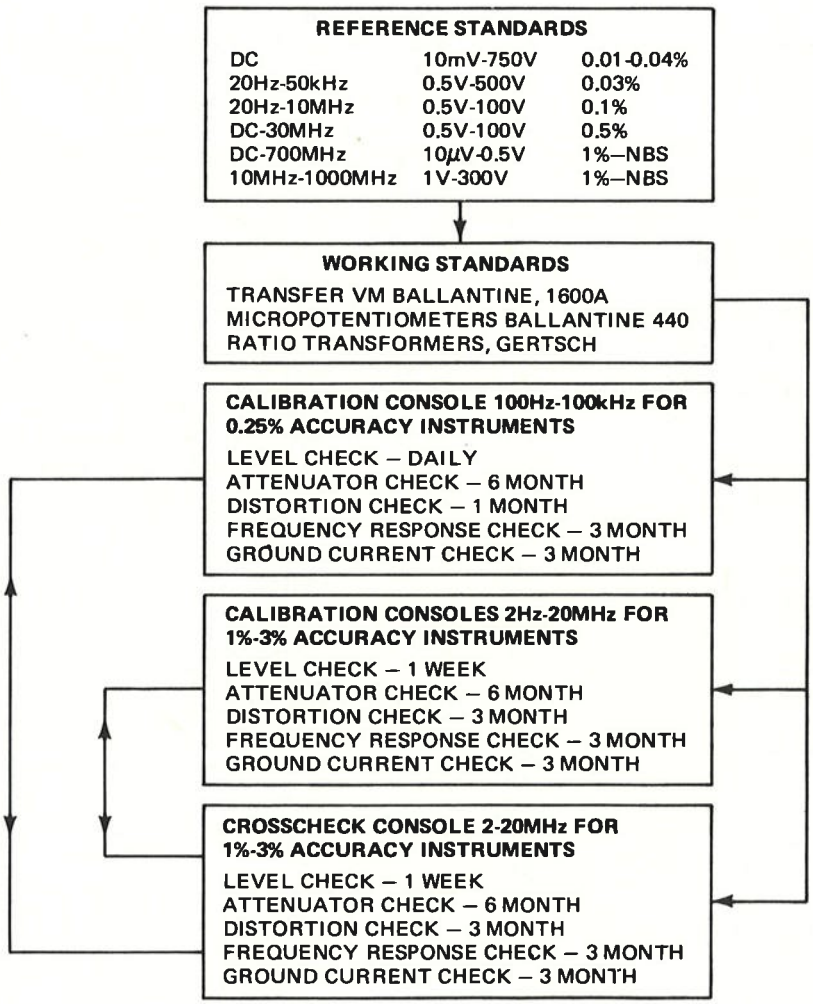
November 1976

WARRANTY

This Ballantine Laboratories, Inc. product is warranted against defects in materials and workmanship for a period of one year from the date of shipment, except for batteries, electron tubes, vacuum thermocouples, and certain other components, if any, listed in this manual. Ballantine Laboratories, Inc. will, at its option, repair or replace products which prove to be defective during the warranty period provided they are returned to Ballantine Laboratories, Inc. prepaid, and provided the proper preventive maintenance and calibration procedures as listed in this manual are followed. Repairs necessitated by misuse of the product are not covered by this warranty. NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BALLANTINE LABORATORIES, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

CERTIFICATION

Ballantine Laboratories, Inc. certifies that this equipment meets all applicable Ballantine specifications at time of shipment as determined by thorough testing and inspection. Ballantine further certifies that its measurements are traceable to the United States National Bureau of Standards. All instruments used in calibrating Ballantine products are standardized by systematic reference to NBS-traceable standards as described in the validation procedures shown below.


REFERENCE STANDARDS
DC 10mV-750V 0.01-0.04%
20Hz-50kHz 0.5V-500V 0.03%
20Hz-10MHz 0.5V-100V 0.1%
DC-30MHz 0.5V-100V 0.5%
DC-700MHz 10μV-0.5V 1%—NBS
10MHz-1000MHz 1V-300V 1%—NBS
WORKING STANDARDS
TRANSFER VM BALLANTINE, 1600A
MICROPOTENTIOMETERS BALLANTINE 440
RATIO TRANSFORMERS, GERTSCH
CALIBRATION CONSOLE 100Hz-100kHz FOR 0.25% ACCURACY INSTRUMENTS
LEVEL CHECK – DAILY
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 1 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CALIBRATION CONSOLES 2Hz-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH
CROSSCHECK CONSOLE 2-20MHz FOR 1%-3% ACCURACY INSTRUMENTS
LEVEL CHECK – 1 WEEK
ATTENUATOR CHECK – 6 MONTH
DISTORTION CHECK – 3 MONTH
FREQUENCY RESPONSE CHECK – 3 MONTH
GROUND CURRENT CHECK – 3 MONTH

Ballantine's Quality Assurance program satisfied the requirements of MIL-I-45208

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Figure 1–1. Model 3055A AC Voltmeter

Figure 1–2. Model 3056A AC Voltmeter

SECTION 1
GENERAL INFORMATION

1–1. INTRODUCTION.

1–2. The Ballantine 3055A and 3056A series of instruments are versatile general purpose, wide-band ac voltmeters, wide-band ac amplifiers and ac to dc converters.

1–3. The 3055A incorporates a digital readout with 2000 count (3½ digit) resolution. The easily read digits are backlit and ½ inch high. Decimal points are automatically positioned by the RANGE switch. The digital display reads the applied input voltage processed by an average responding converter calibrated in rms. Resolution is 100 nanovolts and the 3055A covers a voltage range from 10 μV to 1 kV from 5 Hz to 15 MHz.

1–4. The 3056A incorporates an analog meter with a linear dB scale and a constant accuracy logarithmic voltage scale. The dB scale is referenced to 1 mW into 1000 ohms (dBV) and extends from –20 dB to 0 dB. The voltage scale is below the dB scale and extends from 0.1 to 1. The 3056A also incorporates a relative reference adjustment. The REL REF on the front panel permits continuously variable reduction of meter sensitivity by at least 3.3 dB to permit measurement of relative dB or relative voltage. A detented CAL position is provided on the REL REF control for normal calibrated measurements.

1–5. Since the 3055A and 3056A differ only in having a zero based digital readout and in a linear dB scale analog meter readout plus the incorporation of a REL REF control in the 3056A and a digital display hold feature in the 3055A. All references in this manual to the 3055A series will apply to all instruments unless otherwise noted.

1–6. SPECIFICATIONS.

1–7. Figure 1–1 shows the 3055A and Figure 1–2 shows the 3056A. Table 1–1 provides a list of specifications.

1–8. OPTIONS.

1–9. Option 04 (Rear Panel input connector).

1–10. Option 04 provides a BNC input connector at the rear. The BNC is floating with respect to the chassis and is connected to the front panel BNC thru a short length of 50 Ω coaxial cable.

Input signals may be connected at both the front and rear panel. Input capacity is less than 60 pF on all RANGE switch positions. The instrument is calibrated from the front panel. The BNC cable assembly and a 50 Ω termination should be connected at the front panel to avoid transmission line errors (1.5 nS) when measuring high frequencies with signal input from the rear panel.

1–11. Option 02 (3055A only).

Digital display is reflective type for daylight viewing. Black numerals on light colored background provide best contrast under all external illumination.

1–12. Option 05 (Internal NiCad Battery and Charger – 3056A only).

Option 05 provides internal rechargeable battery operation. A 28 volt multi-cell Nickel Cadmium (NiCad) Battery is mounted within the instrument. When fully charged it will operate the voltmeter for nominally seven to eight hours. The battery may be fully recharged in 16 hours with the battery charger circuit incorporated in the instrument. A rear panel Battery Charge switch S501 will recharge the battery at one tenth rate in the FAST position and will trickle charge in NORM position. FAST should only be used twenty hours at a time. NORM may be used continuously to maintain the battery fully charged.

The internal battery pack is used to operate the meter off-line, in the field, and when full isolation is required to avoid ground current and power line frequency errors.

1–13. When using internal battery operation there is no ground return for the instrument through the power cord. Use caution to avoid electrical shock.

1–14. Option 10 (Constant input capacity).

Option 10 provides constant input capacity (± 1 pF) on all positions of the RANGE switch. Input capacity remains 22 pF ± 2 pF. Constant input capacity permits normalized calibration from a constant impedance source as well as the full use of passive attenuator probes.

1–15. Option 16 (Side Carry Handle).

Option 16 provides for installation of a retractible carrying handle on the decorative strip on the side of the instrument.

1–16. Option 90 – 3056A only.

Option 90 provides additional environmental capability. A special "liquid" damped meter movement as well as additional mechanical supports increase reliability under undue shock and vibration. A humidity sealant is applied to all applicable circuit areas to optimize use in humid and tropical environments.

1–17. Additional options are available on special order to provide customized instruments. These include parallel BCD printer output and external hold and read commands modifications in the 3055A. Contact your Ballantine local engineering representative or the factory for additional information.

TABLE 1–1. SPECIFICATIONS

3055A

Voltage Range: 100 μV full scale to 1 kV full scale in eight decade steps.

Frequency Range: 5 Hz to 15 MHz. Useable 2 Hz to 20 MHz on ranges above 100 μV.

Calibration: Average responding calibrated in rms of sine wave.

Input Impedance: 10 MΩ shunted by <24 pF on 0.1 to 300 mV ranges, and 10 MΩ shunted by 20 pF nominal on 1 V to 1 kV ranges.

Input Terminal: BNC, floating or grounded with respect to chassis.

Over Voltage Protection: 1500 V (dc + pk ac) all ranges. Limited to 10^7 VHz on the 0.1 mV to 100 mV ranges, and 10^8 VHz on 1 V to 1 kV ranges.

Floating Operation: Voltmeter may float with respect to case ground. Front panel switch converts to floating operation. Off-ground operation limited to ±300 V (dc + pk ac). Common mode rejection 120 dB at dc, and 80 dB at 60 Hz on all ranges above 10 mV.

Accuracy: ±(% of Full Range + % of Reading) from 10% of full scale (1999) to 180% of full range (1800)

Frequency	5 Hz	10 Hz	20 Hz	40 Hz	2 MHz	4 MHz	10 MHz	15 MHz
1 mV thru 1 Kv Range	±(5 + 5)	±(2 + 2)	±(2 + 0)	±(1 + 0)	±(1.5 + 1.5)	±(2.5 + 2.5)	±(5 + 5)	

Frequency	10 Hz	20 Hz	40 Hz	100 kHz	500 kHz	4 MHz	10 MHz
100 μV Range	±(5 + 5)	±(2 + 2)	±(1 + 1)	$\pm(\pm 1\ ^{+1}_{-2.5})$	$\pm(\pm 2.5\ ^{+1}_{-2.5})$	Usable	

Accuracy of AC to DC Converter Output: ±(% of Full Range + % of Reading) from 1/3 Full Range to Full Range. AC to DC Converter Accuracy is ¼% of full range better than voltmeter accuracy.

Low Pass Filter: Selectable by front panel switch. 100 kHz low pass. Optimizes measurements on noisy low frequency signals.

Noise: (Referred to input with 1000Ω shielded termination). L.P. Filter in: 12 μV. L.P. Filter out: 25 μV. Note: Noise adds to signal nominally as the relation:

$$\text{Reading} = \sqrt{(\text{signal})^2 + (\text{noise})^2}$$

Meter Response: 1 second to reach full scale from zero.

AC Amplifier Outputs: (Gain +60 dB to –80 dB)

Output (Meter F.S. 10 pF load)	Source Impedance	Frequency Response
150 mV	50 Ω	±10%/5 Hz-1 kHz ± 3%/1 kHz-4 MHz ± 6%/4 MHz-10 MHz
1 V	600 Ω	±10%/20 Hz-1 kHz ± 5%/1 kHz-4 MHz ±20%/4 MHz-10 MHz

AC to DC Converter Output: 1 V dc, open circuit, for full scale meter deflection any range. Output directly proportional to input signal. Source resistance 1000Ω nominal.

Display: 3½ digit digital display. Liquid crystal 17.8mm (0.7 inch) high seven segment numerals 000 to 1999 with automatically positioned decimal point. Display is transmissive and illuminated from an interval lamp. See Option 02 for daylight viewing reflective display. Display zero and full scale adjustments available under snap off front panel bezel. 100 to 1000 plus 100% overrange to 1999.

Range: 100 to 1000 plus 100% overrange to 1999. Display usable from 000 to full scale of 1999.

Overrange: 100% to full scale of 1999. Display flashes to signal overrange beyond 1999 counts.

Resolution: Least significant digit resolves 100 nanovolts on 100 μV range.

TABLE 1–1. SPECIFICATIONS (Continued)

Reading Rate: 3 readings per second in NORMAL mode and on command in HOLD mode by momentary push button RESET switch.

Environmental Characteristics:

	Temperature	Altitude
Operating:	10 to 50°C	0 to 3 km
Non-operating:	–54°C to +75°C	0 to 15 km
Reference Conditions:	25°C to ±5°C	
Humidity:	0 to 95% RH to 45°C	

Power: AC: 103 to 127 V and 206 to 254 V, 48 to 1000 Hz, 5 Watts.
DC: Binding posts are provided on the rear panel to connect floating dc source or battery. Input voltage range from 28 to 44 V dc with current drain of approximately 80 mA. DC power only applicable to ac amplifier and ac to dc converter. 3055A may be operated on external dc with digital display inoperative. Digital display operates only from ac power and may be operated independently from the external dc power used for the ac amplifier and ac to dc converter.

Dimensions: Height: 147 mm (5.81 in.) overall, 132 mm (5.21 in.) case; Width: 211 mm (8.34 in.); Depth: 300 mm (11.83 in.) overall, 267 mm (10.52 in.) case.

Weight: Net: 2.7 kG (6.0 lbs.); Shipping: 4.5 kg (10.0 lbs.).

For Parallel BCD Printer output and external hold and read commands contact factory.

3056A

Voltage Range: 100 μV full scale to 1 kV full scale in eight decade steps.

Frequency Range: 5 Hz to 15 MHz. Useable 2 Hz to 20 MHz on ranges above 100 μV.

Decibel Range: Eight to 20 dB steps from +60 dBV to –100 dBV (useable to –98 dBV).

Scales: Decibels –20 to 0 dB; 100 linear divisions. Volts: 0.1 V to 1 V; logarithmic divisions.

Calibration: Average responding calibrated in rms of sine wave.

Relative Reference: Allows continuous reduction of sensitivity by a minimum of 3.3 dB. Permits 0 dB reference change, and useful in setting meter to conveniently read scale graduation when making relative dB or voltage measurements.

Input Impedance: 10 MΩ shunted by <24 pF on 0.1 to 300 mV ranges, and 10 MΩ shunted by 20 pF nominal on 1 V to 1 kV ranges.

Input Terminal: BNC, floating or grounded with respect to chassis.

Over Voltage Protection: 1500 V (dc + pk ac) all ranges. Limited to 10^7 VHz on the 0.1 mV to 100 mV ranges, and 10^8 VHz on 1 V to 1 kV ranges.

Floating Operation: Voltmeter may float with respect to case ground. Front panel switch converts to floating operation. Off-ground operation limited to ±300 V (dc + pk ac). Common mode rejection 120 dB at dc, and 80 dB at 60 Hz on all ranges above 10 mV.

Accuracy: (% Reading)

Frequency	5 Hz	10 Hz	40 Hz		2 MHz	4 MHz	10 MHz	15 MHz
1 mV to 1 kV RANGES	±0.8dB	±0.4 dB	±0.2 dB		±0.4 dB	±0.6 dB	±0.8 dB	

Frequency	10 Hz	20 Hz	60 Hz	500 kHz	4 MHz	10 MHz
0.1 mV RANGE	±0.8dB	±0.6dB	±0.2 dB	±0.6 dB	Useable	

Low Pass Filter: Selectable by front panel switch. 100 kHz low pass. Optimizes measurements on noisy low frequency signals.

TABLE 1–1. SPECIFICATIONS (Continued)

Noise: (Referred to input with 1000Ω shielded termination) L.P. Filter in: 12 μV. L.P. Filter out: 25μV.
Note: Noise adds to signal nominally as the relation:

$$\text{Reading} = \sqrt{(\text{signal})^2 + (\text{noise})^2}$$

Meter Response: 1 second to reach full scale from zero.

AC Amplifier Outputs: (Gain +60 dB to –80 dB)

Output (Meter F.S. 10 pF load)	Source Impedance	Frequency Response
150 mV	50 Ω	±10%/5 Hz-1 kHz ± 3%/1 kHz-4 MHz ± 6%/4 MHz-10 MHz
1 V	600 Ω	±10%/20 Hz-1 kHz ± 5%/1 kHz-4 MHz ±20%/4 MHz-10 MHz

AC to DC Converter Output: 1 V dc, open circuit, for full scale meter deflection any range. Output directly proportional to input signal. Source resistance 1000Ω nominal. Accuracy ¼% better than voltmeter accuracy.

Environmental Characteristics: Operating: 0° to +55°C; 0 to 3 kM altitude. Non-operating: –54° to +75°C; 0 to 15 kM altitude.

Humidity: 0 to 95% RH to +50°C.

Power: AC; 90-135/180-270V; 47-420 Hz; 5 W. DC: External battery operation with single source of 28-44 V via rear terminals. Optional rechargeable Ni Cad battery, approx. 8 hrs. Operation; 16 hrs. charge; charger included with Option 05.

Dimensions: 133 mm (5¼") H; 216 mm (8½") W; 305 mm (12") D.

Weight: Net 2.7 kg (6 lbs). With battery 3.4 kg (7½ lbs). Shipping 4.5 kg (10 lbs). With battery 5.2 kg (11½ lbs).

1–18. ACCESSORIES.

a. Rack Mount Kit 800-06 mounts one or two 3055A Series voltmeters in a standard E.I.A. 19 inch rack. Rack height is 5.2 inches. A half-panel cover plate P/N 38100371 is required when only one voltmeter is mounted.

b. Probe Kit 10601B
Attenuator Probe
Input impedance 10 MΩ/12 pF
Division Ratio 10:1
Bandwidth dc to 70 MHz
Maximum Input Voltage 600 V rms
Cable length 5 feet (152 cm)

To use this probe, a one megohm adapter, Model 12614A, is required at the voltmeter input connector to match the probe to the 10 megohm voltmeter input.

c. Adapter, BNC to Dual Binding Post Model 12622A

d. 50 Ω Feed-thru termination, BNC to BNC, 2W Model 12630A

e. Protective Carrying Case. Padded vinyl with zipper closure. Model 10755A

f. Shielded input cable 4 feet BNC to BNC, 50 Ω. Model 12249D

g. Shielded input cable 4 feet BNC to Alligator clips. Model 12250D

h. 10 kV ac 10,000:1 capacitive divider probe model 1301A with BNC connector. Usable 10 Hz to 6 MHz.

1–19. INSTRUMENT AND IDENTIFICATION.

1–20. These Ballantine instruments are identified by a two section serial number. The first three digits section of this number must appear on the title page of this manual. Addendum sheets supplied with the manual will define technical corrections differences between your instrument and the unit described in this manual.

1–21. If applicable, back dating information is located at the very end of this manual in Section 7. This backdating information pertains to instruments with serial number prefixes listed on the title page of this manual.

SECTION 2
INSTALLATION

2–1. INTRODUCTION.

2–2. This section contains information and instructions necessary for the installation and shipping of the Model 3055A series Voltmeters. Details are provided for initial inspection, power connection, grounding safety requirements, installation information, and repacking instructions for storage or shipment.

2–3. UNPACKING AND INITIAL INSPECTION.

2–4. Unpacking and handling of the voltmeter requires only the normal precautions and procedures applicable to the handling of sensitive electronic equipment. The contents of all shipping containers should be checked for included accessories and certified against the packing slip to ascertain that the shipment is complete.

2–5. This instrument was carefully inspected for mechanical and electrical performance before shipment from the factory. It should be free of physical defects and in perfect electrical order upon receipt. Check the instrument for damage in transit and perform the electrical procedure outlined in paragraph 5–9. If there is indication of damage or deficiency see the warranty in this manual and notify your local Ballantine field engineering representative or the factory.

CAUTION

It is recommended that the operator be fully familiar with the specifications and all sections of this manual. Failure to do so may compromise the warranty and the accuracy which Ballantine has engineered into your instrument.

2–6. POWER REQUIREMENTS.

2–7. The instrument may be operated from:

a. Any source of ac line voltage from 90 to 135 Volts rms and 180 to 270 Volts rms at 48 to 1000 Hz. The voltage selector switch on the rear panel selects the desired voltage. Failure to have this switch properly set may damage the instrument and void the warranty.

b. One 28 to 44 Volt battery or floating dc power supply connected to the EXT. BAT. binding posts on the rear panel. Current requirements are nominally 80 mA. The front panel power switch also disconnects the external battery.

c. Internal rechargeable battery power supply; (Optional) Option 05. A 28 Volt NiCad battery and charger are installed in the voltmeter. A fully charged battery will operate the instrument for 8 hours. A rear panel mounted INT. BAT. CHARGE switch will select 16 hour recharge from the power line when in FAST position and will maintain full charge in NORM (trickle charge) position. The ac and dc input requirements specified previously apply since battery charging may be accomplished with ac or dc power input.

The dc battery charge input voltage is 35 V to 44 V. The ac input voltage is limited to 115/230 V ± 10%.

Be sure to FAST charge the internal battery for eight hours after extended storage or after receiving the instrument from the factory.

Note

To charge the battery, the front panel power switch must be ON and the pilot lamp illuminated.

When operating on internal batteries, the pilot lamp also indicates power ON operation and is illuminated to act as a battery charge indicator as long as sufficient battery charge is available to power the instrument.

2–8. GROUNDING REQUIREMENTS.

2–9. To insure the safety of operating personnel, the U.S. O.S.H.A. (Occupational Safety and Health) requirement and good engineering practice mandate that the instrument panel and enclosure be "earth" grounded. All Ballantine instruments are provided with an Underwriters Laboratories (U.L. and C.S.A.) listed three conductor power cable, which when plugged into an appropriate power receptacle, grounds the instrument. The long offset pin on the male end of the power cable carries the ground wire to the long pin of the Euro connector (DIN standard) receptacle on the rear panel of the instrument.

2–10. To preserve the safety protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green lead on the adapter to an "earth" ground.

2–11. When using external dc power or internal battery operation there is no ground return through the power cord. Use caution to avoid electrical shock and consider connecting the instrument cabinet to earth ground through J8, the rear panel ground binding post connector.

2–12. INSTALLATION AND MOUNTING.

2–13. The instrument is fully solid state and dissipates minimal power. No special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F), when the relative humidity exceeds 95% or condensation appears anywhere on the instrument.

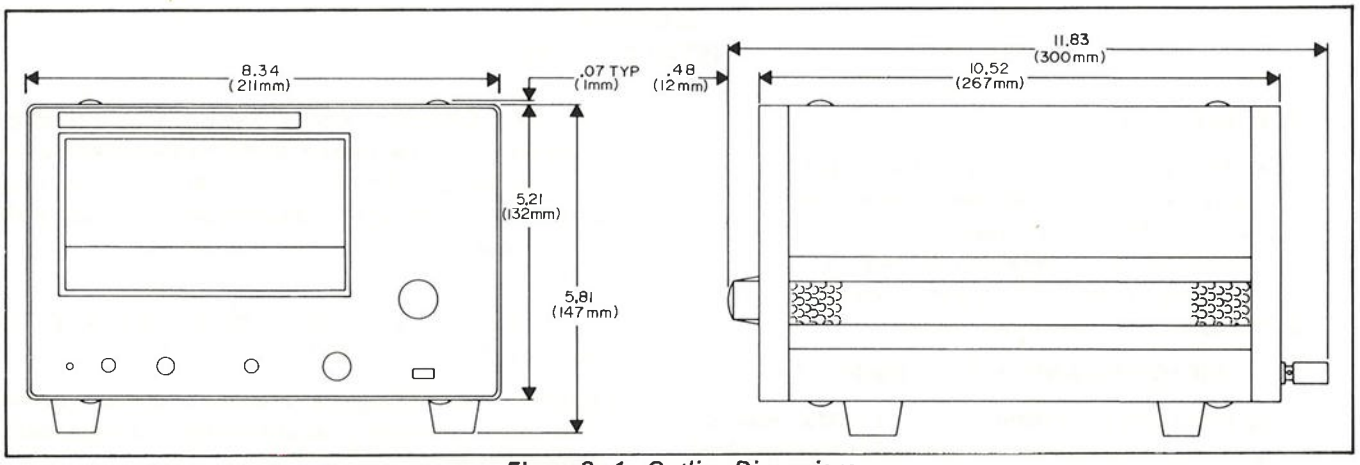


Figure 2–1. Outline Dimensions

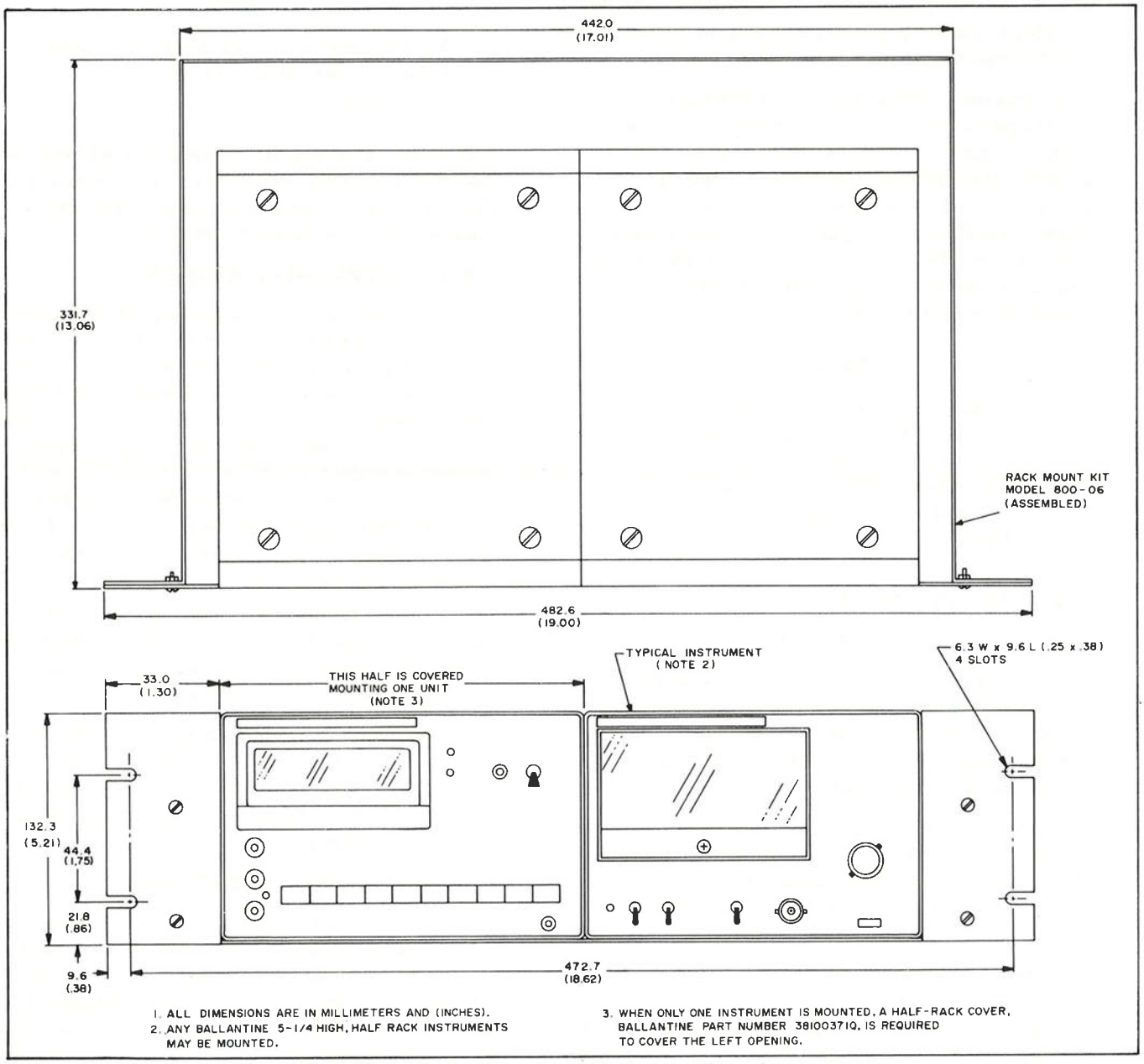


Figure 2–2. Rack Mounting Outline Dimensions

2–14. BENCH MOUNTING.

2–15. The instrument is shipped with plastic feet and tilt stand in place and ready for use as a bench or portable instrument. See outline drawing Figure 2–1 for dimensions.

2–16. The instrument may be rack mounted in a standard 19 inch EIA rack. The instrument is of half rack configuration and one or two instruments may be rack mounted in Rack Mount Kit Model 800-06. If only one unit is to be mounted, order cover plate Ballantine part number 38100371. See Figure 2–2 for outline dimensions. Remove plastic feet and tilt stand from bottom cover of voltmeter before mounting in rack adapter.

2–17. PORTABLE USE.

2–18. The instrument may be used in applications requiring portability. A side carry handle (Option 16) and splash proof vinyl protective carry case with zipper closure (Ballantine Model 10755A) are optionally available.

2–19. SHORT TERM STORAGE.

2–20. If the instrument is to be stored for a short period of time (less than three months) place cardboard over the panel, and cover the instrument with suitable protective covering such as a plastic bag or strong kraft paper. If the instrument incorporates a rechargeable NiCad battery (Option 05) first fully charge the battery. Place power cable and other accessories with the instrument. Store the covered voltmeter in a clean dry area that is not subject to extreme temperature variations or conditions which may cause moisture to condense on the instrument.

2–21. LONG TERM STORAGE OR REPACKAGING FOR SHIPMENT.

2–22. If the instrument is to be stored for a long period or shipped, proceed as directed below. If you have any questions contact your local Ballantine field engineering representative or the Ballantine Service Department at the factory.

2–23. If the original Ballantine supplied packing is to be used proceed as follows:

a. If the original wrappings, packing material and container have been saved, repack the instrument and accessories originally shipped to you. If the original container is not available, one may be purchased thru the Ballantine Service Department at the factory.

b. Be sure the carton is well sealed with strong tape or metal straps.

c. Mark the carton with the model number and serial number with indelible marking. If it is to be shipped, show sending address and return address on two sides of the box and cover all previous shipping labels.

2–24. If the original container is not available, proceed as follows:

a. Before packing the unit, place all accessories into a plastic bag and seal the bag.

b. For extended storage or long shipping only use U.S. Government packaging method II C and tape a two-unit bag of desiccant (per MIL-D-3464) on the rear cover.

c. Place a 13 cm (5 inch) by 20 cm (8 inch) piece of sturdy cardboard over the front panel for protection.

d. Place the voltmeter into a plastic bag and seal the bag.

e. Wrap the bagged instrument and accessories in one inch thick flexible cellular plastic film cushioning material (per PPP-C-795) and place in a barrier bag (per MIL-B-131). Extract air from bag and heat seal.

f. Place bagged instrument and accessories into a 250mm (10 inch) x 200mm (8 inch) x 310mm (12 inch) fiber board box (per PPP-B-636 type CF, class WR, variety SW, grade V3C). Fill additional spaces with rubberized hair or cellular plastic cushioning material. Close box in accordance with container specifications. Seal with sturdy water resistant tape or metal straps.

g. Mark container "DELICATE INSTRUMENT", "FRAGILE", etc. Mark instrument model and serial number and date of packaging. Affix shipping labels as required or mark according to MIL-STD-129.

Note

If the instrument is to be shipped to Ballantine for calibration or repair attach a tag to the instrument fully identifying the owner (with contact, company name, address, telephone number) and complete details indicating the problem, symptoms, and service or repair to be performed. Always include the model and serial number of the instrument on the tag. If possible ship by air freight. In any correspondence, identify the instrument by model number, complete serial number, work authorization order, and date and method of shipment to Ballantine.

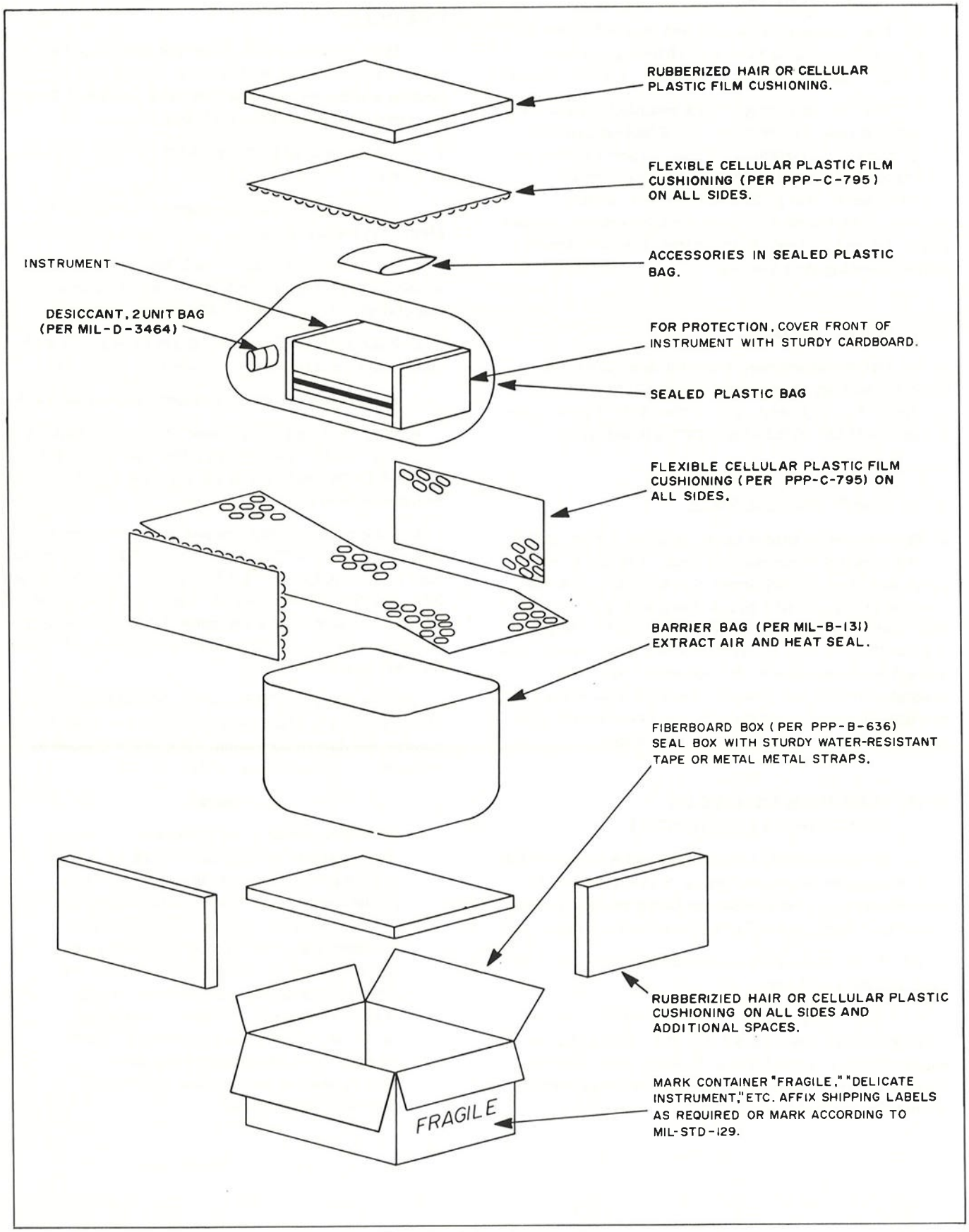

RUBBERIZED HAIR OR CELLULAR PLASTIC FILM CUSHIONING.
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
ACCESSORIES IN SEALED PLASTIC BAG.
INSTRUMENT
DESICCANT, 2 UNIT BAG (PER MIL-D-3464)
FOR PROTECTION, COVER FRONT OF INSTRUMENT WITH STURDY CARDBOARD.
SEALED PLASTIC BAG
FLEXIBLE CELLULAR PLASTIC FILM CUSHIONING (PER PPP-C-795) ON ALL SIDES.
BARRIER BAG (PER MIL-B-131) EXTRACT AIR AND HEAT SEAL.
FIBERBOARD BOX (PER PPP-B-636) SEAL BOX WITH STURDY WATER-RESISTANT TAPE OR METAL METAL STRAPS.
RUBBERIZIED HAIR OR CELLULAR PLASTIC CUSHIONING ON ALL SIDES AND ADDITIONAL SPACES.
FRAGILE
MARK CONTAINER "FRAGILE," "DELICATE INSTRUMENT," ETC. AFFIX SHIPPING LABELS AS REQUIRED OR MARK ACCORDING TO MIL-STD-129.

Figure 2–3. Packing Drawing

SECTION 3
OPERATING INSTRUCTIONS

3–1. INTRODUCTION.

3–2. This section contains instructions and information required for the operation of the Ballantine 3055 Series of AC Voltmeters. Included are identification of controls, connectors, options and indicators as well as turn on procedures and operating instructions.

3–3. CONTROLS, INDICATORS and CONNECTORS.

3–4. The instrument controls, indicators, and connectors are identified on Figures 3–1 through 3–3 and described in Table 3–1.

3–5. METER MECHANICAL ZERO ADJUSTMENT (3056A ONLY).

3–6. The mechanical meter zero adjustment is a screwdriver adjustment located in the center of the meter just below the scale.

Note

DO NOT adjust the mechanical meter zero on the 3056A meters with logarithmic movements. These meters are carefully set by the manufacturer and meter linearity may be destroyed if the user misadjusts the mechanical zero adjust on non-zero voltage scale meters.

3–7. POWER REQUIREMENTS.

a. **AC Line Voltage Power.** If ac line voltage power is used, be sure that the Voltage Selector Switch on the rear panel is in the correct position.

WARNING

FAILURE TO HAVE THE VOLTAGE SELECTOR SWITCH IN THE CORRECT POSITION CAN CAUSE SERIOUS DAMAGE TO YOUR INSTRUMENT AND MAY VOID THE WARRANTY.

Turn the power ON toggle switch to ON and note that the pilot lamp will light when the power is applied.

b. **External DC/Battery Power.** If external dc power supply or batteries are used to power the instrument, connect either to the binding post connectors J6 and J7 on the rear panel. The dc power source must be floating with respect to the input connections of the voltmeter. Observe polarity by always connecting positive to J6. Input voltage, including any ripple, must be between the limits of 28 and 44 volts. The power ON switch also controls the dc power input. Turn the power ON toggle switch to ON and note that the pilot lamp will light when power is applied.

Note

On the 3055A only the ac amplifier and dc converter may be operated from external dc power. The digital display meter must always be operated from ac power. Disconnect the ac powered internal dc supply by opening the printed circuit connection between A1CR401 to A1R401 or by providing a separate 115 V AC input only for the meter. Restore these modifications for normal ac powered operation. The 3055A ac amplifier and dc converter may also be operated from external dc power only but the digital display will be inoperative.

c. **Internal Battery (Option 05 – 3056A only).** If the optional rechargeable Ni-Cad battery pack is installed in the instrument simply turn the power ON toggle switch to ON and note that the pilot lamp lights when power is applied. The pilot lamp serves as a battery charge indicator and if it glows dimly or does not light when the power ON toggle switch is turned to ON, it indicates that the internal battery is discharged.

To recharge the battery (which should always be done after shipment or storage) set the BATTERY CHARGE slide switch (S501) located on the rear panel to FAST. Power the instrument either from ac line or an external dc source and turn the power ON toggle switch to ON. The instrument now functions normally and will also recharge the internal battery. Allow 16 hours FAST battery charge to fully recharge a discharged battery. A fully charged battery will power the 3055A for approximately 8 hours.

CAUTION

The internal battery should not be FAST charged continuously or its life may be shortened. Avoid FAST charge for more than 20 continuous hours. Always keep S501 in NORM mode when continuously using external dc or ac line power input to maintain the internal battery fully charged.

3–8. AC VOLTAGE MEASUREMENTS.

3–9. The 3055A series of voltmeters are average responding and calibrated in rms of a sine wave. RMS calibration is used since rms provides the true measure of power capability or heating value of the input signal waveform.

3–10. If the ac signal under test is not sinusoidal the resulting rms measurement error may be appreciable. The amount of error depends on distortion from sine wave in

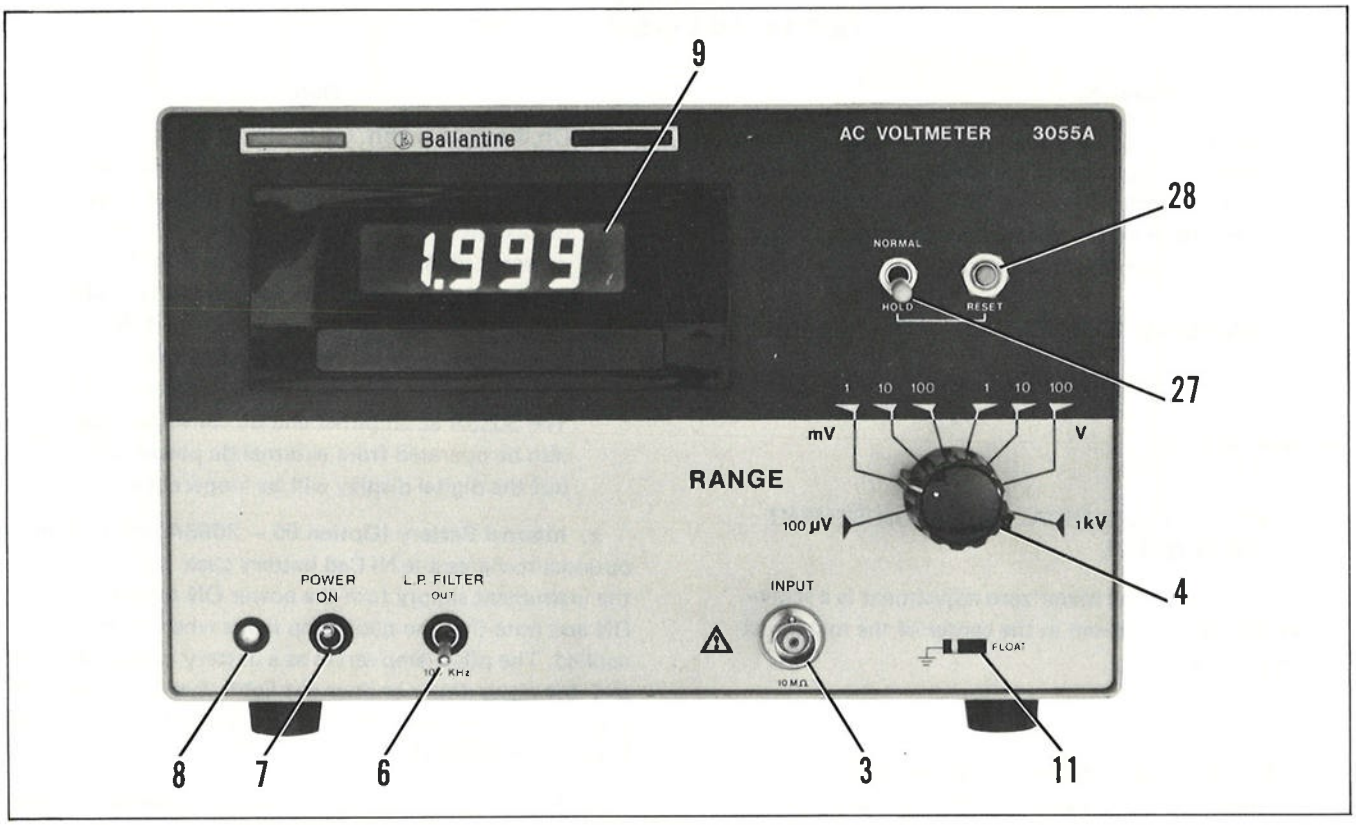


Figure 3–1. Model 3055A Front Panel

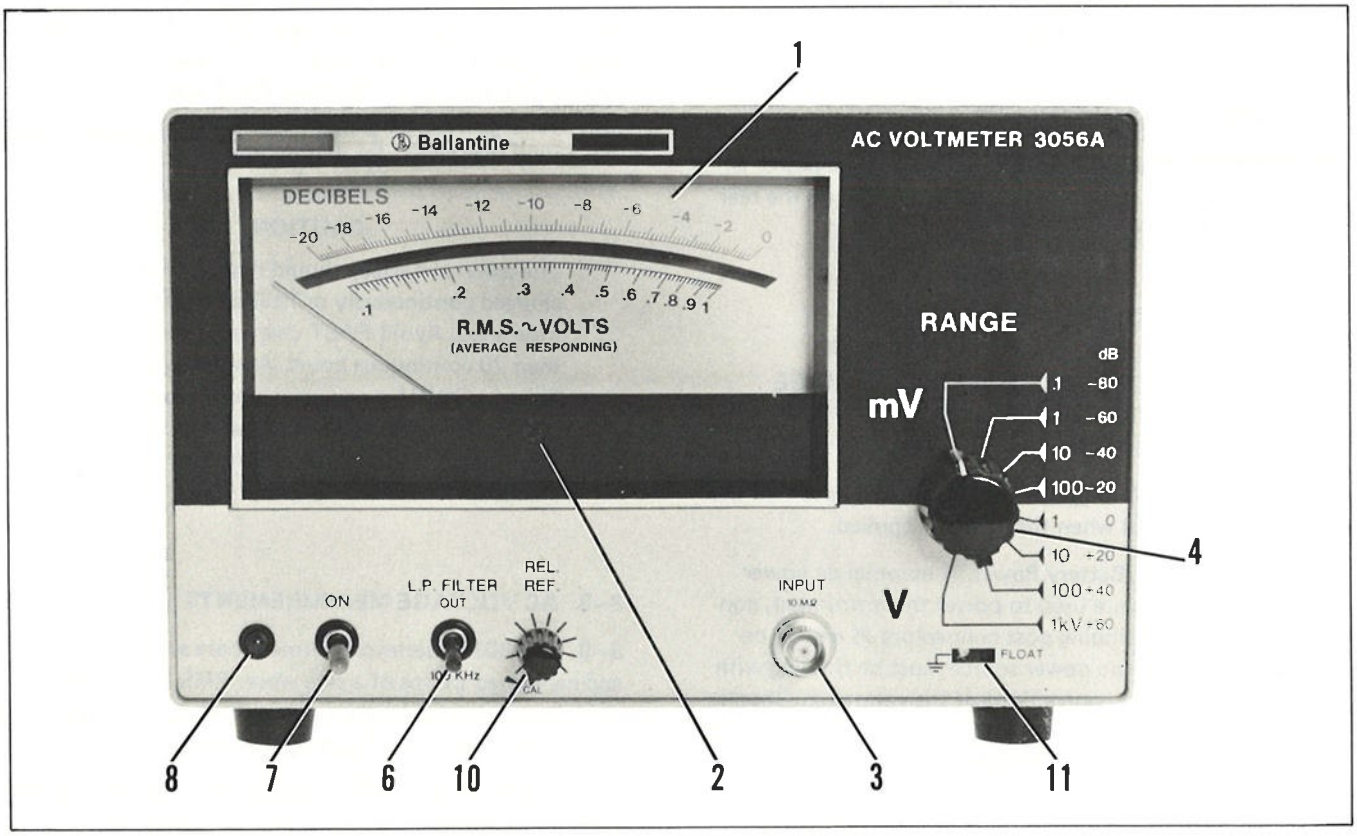


Figure 3–2. Model 3056A Front Panel

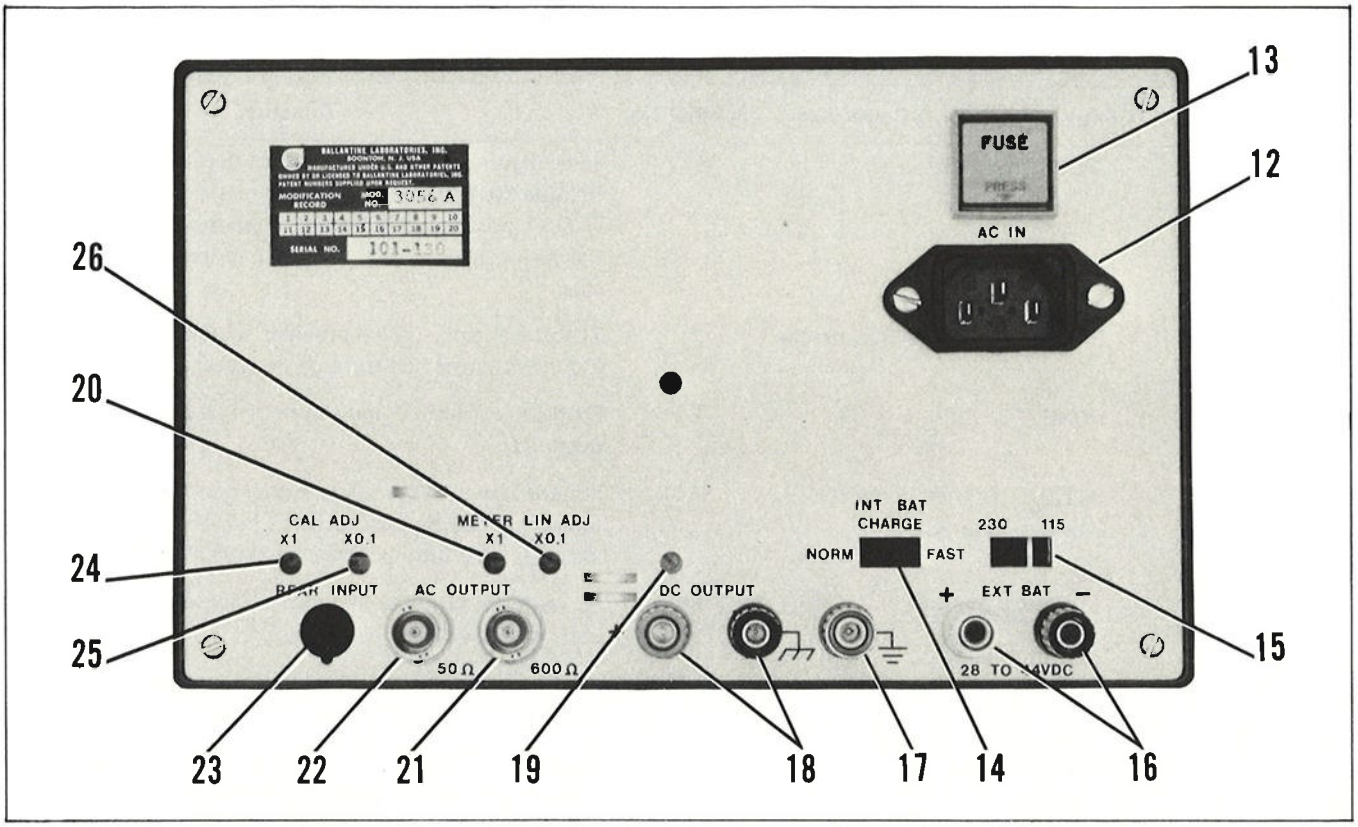


Figure 3–3. Rear Panel Connectors

TABLE 3–1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO.	Control, Indicator & Connector	Symbol No.	Function
1	3056A Scale		Indicates magnitude of applied signal in rms ac volts and dBm.
2	Meter Mechanical Zero Adj.		DO NOT USE
3	INPUT Connector	J1	Connects signal to be measured to the voltmeter.
4	RANGE Selector	S1	Selects full scale reading on meter. DB setting of RANGE switch adds directly to dBm reading on scale.
6	L.P. FILTER	S4	Switches 100 kHz filter either in or out of circuit.
7	Power ON Switch	S3	Applies dc power from internal battery or external battery to circuit power supplies. Switch must be ON to recharge batteries. When switch is OFF it places a short across the meter movement during transportation in rugged environments.
8	Power Indicator Lamp	DS1	Indicates application of power to the voltmeter circuits and also serves as internal battery charge indicator when Option 05 is installed.
9	3055A Digital Meter	–	Indicates magnitude of applied signal in rms ac volts. Digital Indication is 3-1/2 digits (1999 counts)
10	REL. REF. Control (3056A only)	R601/S601	Provides calibrated operation in CAL position and permits continuously variable sensitivity control with –3.2 dBm range to permit measurements against a relative reference.

TABLE 3–1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

INDEX NO.	Control, Indicator & Connector	Symbol No.	Function
11	FLOAT Switch	S10	Screwdriver activated slide switch permits selection of floating "off ground" voltmeter measurements when in FLOAT position and in normal use the position ties the shell (signal LO) of the input connector J1 to the case.
12	Primary AC Power Receptacle	J5	The power cable which provides ac power and "earth" ground is connected through this receptacle.
13	FUSE	F1	Protects instrument and ac power line against current overload.
14	INT BAT CHARGE Switch (Option 05 only)	S501	Screwdriver activated slide switch permits 16 hour internal NiCad battery recharge in FAST position and keeps battery fully trickle-charged in NORM position.
15	115-230V Switch	S6	Screwdriver activated slide switch selects 115 or 230 volts ac power line operation.
16	EXT BAT	J6 (Pos) J7 (Neg)	Binding post terminals for connecting external floating dc power source or battery.
17	Case Ground Terminal	J8	Binding post terminal to connect "earth" ground to cabinet case when not using grounded ac primary power input.
18	DC OUTPUT	J9 (Neg) J10 (Pos)	AC to DC converter output. DC voltage is proportional to percentage meter deflection. Output impedance is nominally 500 Ω.
19	DC OUTPUT Adj.	R247	Screwdriver service adjustment sets 1 volt dc output at full scale reading of the meter.
20	METER LINEARITY (X1)	R243	Screwdriver service adjustment sets meter linearity tracking on the mV range.
21	AC OUTPUT –600 Ω	J3	BNC connector with shell tied to circuit ground provides ac amplifier 1 volt open circuit output. Output impedance 600 Ω.
22	AC OUTPUT –50 Ω	J2	BNC connector with shell tied to circuit ground provides AC amplifier 150 mV open circuit output. Output impedance 50 Ω.
23	REAR INPUT (MOD-04 ONLY)	J701	Optional BNC connector with shell tied to circuit ground. Provides for rear entry of input signal in rack mount installations.
24	CAL ADJ X1	R241	Screwdriver service adjustment sets full scale sensitivity on 100 mV range (S1).
25	CAL ADJ (X0.1) 100 μV Range	R239	Screwdriver service adjustment sets full scale sensitivity on 100 μV range (S1).
26	METER LINEARITY (X0.1) 100 μV Range	R257	Screwdriver service adjustment sets linearity on the 100 μV range.
27	NORMAL/HOLD (3055A only)	S800	Permits display HOLD capability until updated by RESET pushbutton switch.
28	RESET (3055A only)	S801	Updates display on command (push).

the input signal and is related to the number of harmonics present as well as their phase relationships. Table 3–2 shows the errors caused by harmonic distortion.

3–11. An unknown input voltage should be checked for waveform distortion on an oscilloscope. Signals which deviate greatly from sine wave shape should be measured with a TRUE RMS RESPONDING meter such as the Ballantine 3620A or 323L.

3–12. Figure 3–4 shows the voltage relationships of a sine wave. For each half cycle

$$E_{rms} = 0.707 \times E_{peak}$$

$$E_{avg} = 0.636 \times E_{peak}$$

Figure 3–4 also provides a simple table for converting any sine wave value to the other values. As an example, simply multiply peak to peak by 0.353 to obtain the rms value.

3–13. SOURCES OF MEASUREMENT ERROR.

a. The 3055A series of voltmeters are very wide bandwith instruments with extremely high sensitivity. Great care must be exercised with the input signal connections, especially when low level and high frequency measurements are being made. Use an input divider probe or terminated coaxial connections whenever possible.

b. Care must be exercised by the operator to minimize input test lead capacity to reduce loading of the circuit under test. It is important to maintain the integrity of the voltage during measurement with the voltage existing at the test point when the voltmeter leads are not connected.

c. The input of the 3055A series is 10 Megohms shunted by 24 pF (held constant for all ranges when Option 10 is installed). Open wire test leads may add another 25 pF to 50 pF or more if leads are twisted to minimize stray pickup or run over a "ground plane".

d. The loading factor of the total shunt capacity may be determined by the following relationship:

$$X_C \text{ (Ohms)} = \frac{1}{2\pi f_C C}$$

Where f_C is frequency in Hz and C is capacitance in Farads. For example, 50 pF shunt capacitance at 6 MHz is:

$$X_C = \frac{1}{6.28 \times 6 \times 10^6 \times 50 \times 10^{-12}}$$

$$= \frac{1}{6.28 \times 300 \times 10^{-6}} = \frac{1}{1.884 \times 10^{-3}}$$

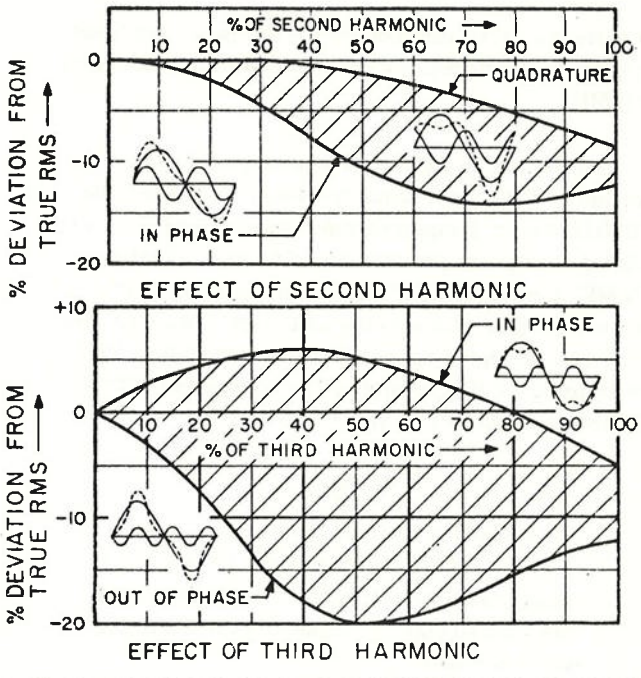
= 530 Ohms of reactive loading

e. This is very low impedance compared to the 10 Megohm input resistance of the instrument and may present a considerable error by loading the test point. In fact, to achieve less than 1% error in voltmeter reading accuracy due to capacitive loading, the test point source impedance should be less than one one-hundredth of the combined capacitive loading impedance of the voltmeter and test leads. In the foregoing example the test point source impedance should be less than 5.3 Ohms if the measurement error due to capacitive loading is to be less than 1% at 6 MHz.

TABLE 3–2. EFFECTS OF DISTORTION ON ACCURACY

HARMONIC	% DISTORTION	% ERROR (* Fundamental)	
		MAX. POSITIVE	MAX. NEGATIVE
Any even	0.1	0.000	
	0.5	0.001	
	1.0	0.005	
	2.0	0.020	
Third	0.1	0.033	0.033
	0.5	0.168	0.167
	1.0	0.338	0.328
	2.0	0.687	0.667
Fifth	0.1	0.020	0.020
	0.5	0.101	0.099
	1.0	0.205	0.195
	2.0	0.420	0.380

*Depends on phase relationship between harmonic and fundamental.



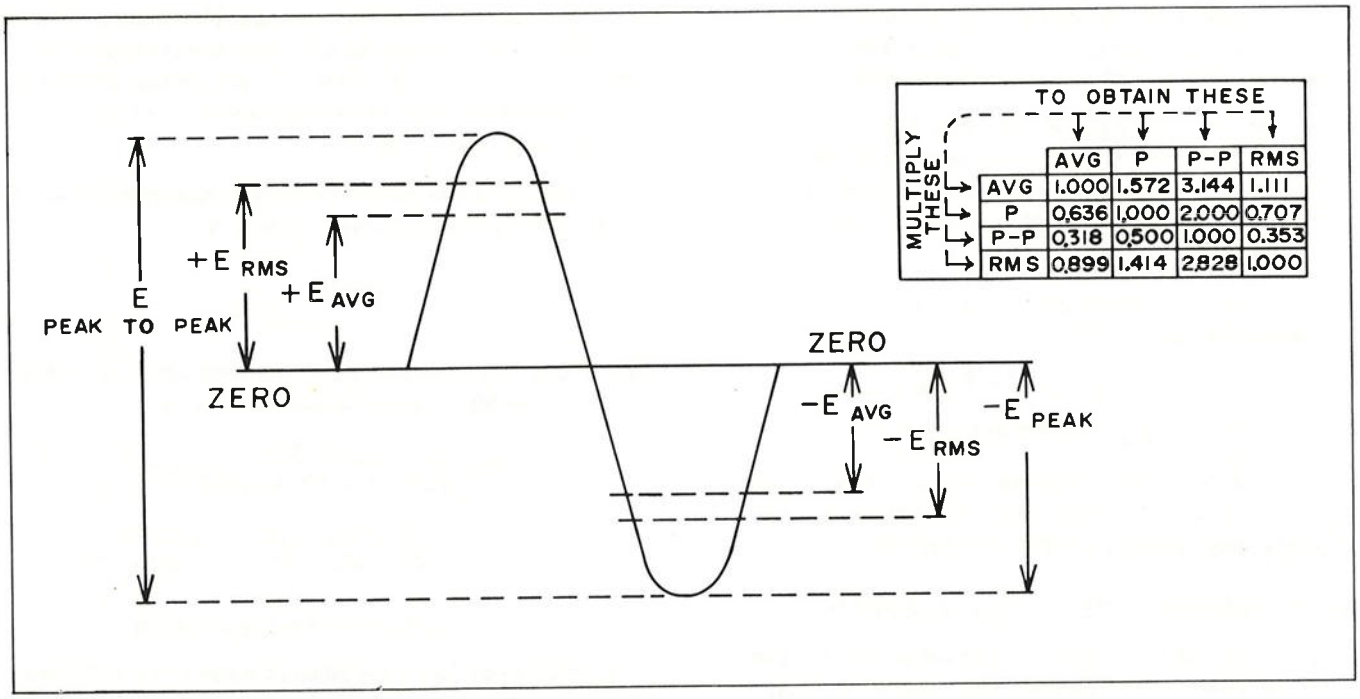


Figure 3–4. Voltage Relationships

f. The loading effect becomes more important at higher frequencies but is present even at power line frequencies.

g. In addition, ac current will flow thru the test leads because of the lower input impedance of the instrument at higher frequencies. Again referring to the above example and assuming a 10 Volt ac rms signal input, then

$$I = \frac{E}{X_C} = \frac{10V}{530\Omega} = 18 \text{ mA}$$

of current must be supplied by the test point and flows thru the test leads and the input circuit of the voltmeter at 6 MHz.

h. To minimize capacitive loading and to provide shielding of the input signal test leads use of the Ballantine 10601A divider probe is recommended. This 5 foot long 10:1 divider probe presents a load of approximately 10 MΩ shunted by 15 pF when compensated to the voltmeter input. Multiply the voltmeter sensitivity with the range multiplier toggle switch by setting it to X0.1 when using the divider probe. The meter and RANGE Switch will then still be direct reading.

Note

The Ballantine 12614A adapter is required to match the 10601B probe to the 10 MΩ input resistance of the voltmeter. The Model 1301A 10 kV ac 10,000 to 1 capacitive divider probe is also available.

i. A 50 Ω terminated coaxial input cable is recommended whenever input signals above 1 MHz are to be measured. Use of the Ballantine 12631A 50 Ω BNC feed thru termination is recommended as is the 12249D 120cm long BNC-BNC shielded cable. Always place the terminating resistor at the input connector of the voltmeter.

Note

When using rear panel input connection (Option 04) always terminate in 50 Ω at the FRONT panel to avoid increased input capacity loading and transmission line effects. The instrument is calibrated with 50 Ohm source impedance at the front panel.

3–14. Some test points or input connections may exhibit negative reactance when connected to the voltmeter. Oscillations may result which give meter readings even in the absence of an input signal. Avoid inductive or resonant sources and, if necessary, place a small resistor (10 Ω to 220 Ω) in series with the voltmeter input at the input connector.

3–15. TRANSMISSION LINE ERROR.

a. At higher frequencies and when using long lengths of connecting coax cable, calibration errors caused by propagation time delay, and standing waves in unmatched and unterminated systems may result.

b. Always use a matched and terminated coax connecting system to limit transmission line errors.

3–16. GROUND CURRENT ERRORS.

3–17. A common source of measurement error in low signal level measurements is extraneous ground current. This ground current is normally a power line current or other frequency not part of the signal to be measured but which flows in the ground lead impedance. This results in an unwanted voltage appearing in addition to the signal at the input BNC connector. The effects of such ground currents may be reduced or eliminated by:

a. Employing twisted or coaxial signal leads and keeping these as short and direct as possible.

b. Using only one power line earth return for all the equipment relating to the measurement set up.

c. Eliminating or reducing ground currents where possible. Isolation transformers with low interwinding capacitance, shielding, and high series resistance when connected in power lines are effective in breaking power line and other low frequency ground loops.

d. Marking all ground impedances, signal return paths and earth ground impedances as low as possible.

e. Operating the voltmeter on internal batteries (Option 05).

f. Operating the voltmeter from an isolated and floating external battery.

g. Operating the voltmeter with the front panel FLOAT slide switch in FLOAT position (above 10 mV RANGE).

3–18. MAGNETIC AND/OR ELECTROSTATIC FIELD ERRORS.

3–19. Strong electrostatic and/or magnetic fields close to the signal leads, or to the voltmeter itself may give rise to appreciable measurement errors. Always use shielded or twisted signal input test leads. Avoid running the signal input leads near cables carrying large currents, or close to switching regulators, power transformers, heaters, etc. Avoid proximity to unshielded signal sources such as instruments in plastic cases, unshielded oscillators, signal generators or function generators. DO NOT mount the instrument close to magnetic power regulators, motors, switching regulators or other high current or high impulse equipment. In general, effective signal or double shielding as well as distance may be used to eliminate errors of this nature.

3–20. INFLUENCE OF AMBIENT TEMPERATURE.

3–21. The instrument is usable on "TURN ON" and will be within 0.5% of final value within 10 minutes at reference condition.

3–22. The accuracies apply at reference conditions and additional uncertainty of half the accuracy is incurred over the range of +10°C to +40°C and again from 0°C to +55°C in the 3056A and +10 to +50°C in the 3055A.

3–23. OFF GROUND MEASUREMENTS.

3–24. Most of the 3055A series voltmeters offer a floating or grounded mode of operation. A slide switch on the front panel is provided to either connect the signal LO (BNC input connector shell) to the case or to permit the voltmeter circuits to "FLOAT" with respect to the case. Off ground measurements may be made up to ±300 volts peak (signal LO to case) in the FLOAT mode. DO NOT use FLOAT mode on the 100 μV thru 10 mV ranges.

3–25. The FLOAT mode permits the voltmeter to measure signals offset on dc voltages and to reduce the effects of unwanted ac voltages which appear "common mode" on both the input signal HI and LO lines with respect to earth ground.

3–26. The voltmeter may also be floated with nominal shunt capacity to ground (approximately 10 pF on a wooden lab bench and several feet from the nearest metal object) by using floating external battery power or internal batteries (Option 05). When using internal batteries "OFF LINE" and FLOAT mode, the voltmeter will not respond to off ground dc or common mode ac voltages and will have virtually infinite common mode signal rejection.

WARNING

Use care to avoid shock hazard whenever operating the voltmeter without having its case tied to power line earth ground.

3–27. AC VOLTAGE MEASUREMENTS.

3–28. Perform the turn on steps listed in paragraphs 3–5 and 3–7.

3–29. Set the meter RANGE switch and RANGE multiplier to the approximate range to be measured. Set the L.P. FILTER to OFF unless only signals under 10 kHz are to be measured. In the 3046A, set the REL REF. control to CAL.

CAUTION

DO NOT APPLY MORE THAN 1000 VOLTS TO THE INPUT BNC CONNECTOR OR FLOAT THE INSTRUMENT BY MORE THAN 300 VOLTS. DO NOT OVERLOAD the 100 V and 1 kV ranges with signals in excess of 10^7 VOLT HERTZ or the 1 volt to 100 volt ranges in excess of 10^8 VOLT HERTZ. If any of these overloads are exceeded the instrument may be damaged and the warranty voided.

3–30. If the signal to be measured is a frequency less than 10 kHz, the L.P. FILTER may be switched in to filter out signal components over 100 kHz.

3–31. Connect the signal to be measured to the INPUT BNC CONNECTOR. The meter will then indicate the rms value of the input sine wave signal.

3–32. NOISE MEASUREMENTS.

3–33. For acurate measurements of highly distorted signals or noise, the Ballantine TRUE RMS Voltmeter Model 323L is recommended. However, for relative measurements or random (white) noise measurements, the 3045A series can be useful. If the voltage to be measured is white noise with an approximate Gaussian distribution, and the noise bandwidth does not exceed 18 MHz, a good approximation to the true rms voltage of the noise input is obtained by adding 13% to the indicated voltage. DO NOT overload the amplifiers of the 3055A series with noise and, if possible, take readings only below mid scale meter indication.

3–34. AC CURRENT MEASUREMENTS.

3–35. Use Ballantine Series 600 precision shunt resistors to accurately measure AC currents from 100 nA to 10 Amperes. Use the voltmeter in FLOAT mode to simplify current measurements. Use Ballantine 12622A BNC to dual binding post adapter to match shunts to the INPUT BNC (J1) Connector. Contact your Ballantine field engineering representative for information on these shunts and other accessories.

3–36. Always use a minimum resistance non-inductive shunt. Convert the rms voltage meter indications into current by

$$\text{I AMPS} = \frac{\text{METER INDICATION IN VOLTS}}{\text{SHUNT RESISTANCE IN OHMS}}$$

3–37. DB MEASUREMENTS – 3056A ONLY.

3–38. Perform the turn on steps listed in paragraphs 3–5, 3–7 and 3–28.

3–39. The dB measurement is equal to the arithmetic sum of the meter indication, the RANGE switch setting and the RANGE MULTIPLIER toggle switch setting (X1 add 0 dB and X0.1 add –20 dB). For example:

RANGE switch setting . . . . . 20 dB
RANGE multiplier X1 . . . . . 0 dB
Meter indication . . . . . –5 dB

Then the actual dB measurement is +15 dB.

3–40. The dB scale of the Model 3056A is calibrated in dBm. Zero dBm is equivalent to 1 milliwatt dissipated by a 1000 Ohm load. Therefore, all dBm measurements must be made across a total load impedance of 1000 Ohms. One mW into 1000 Ohms will make 0 dBm equate with 1.000 volts. Measurement across all other impedances will be in dB, and not in dBm.

3–41. A reading in dB may be converted to dBm by using the Impedance Correction Graph of Figure 3–5. As an example, to convert a +26 dB meter reading across 50 Ohms to dBm (referenced to 1 milliwatt) locate the 50 Ohm load impedance line at the left side of the graph. Follow this impedance line to the heavy black line and read the Meter correction in dBm at the intersection point. The correction for 50 Ohms is +13.01 dBm and the corrected reading for this example is +39.01 dBm.

3–42. The dB reading may also be converted to other reference levels by using the conversion figures of Table 3–3.

TABLE 3–3. dB CONVERSION.

REFERENCE	LEVEL	dB CONVERSION	
1.000V, 1 mW in	1000 Ω	Add	0 dBm
0.775V, 1 mW in	600 Ω	Add	+2.21 dBm
0.274V, 1 mW in	75 Ω	Add	+11.24 dBm
0.224V, 1 mW in	50 Ω	Add	+13.01 dBm

3–43. The 3056A incorporates a relative reference adjustment. This control permits the meter indication to be continuously varied by more than –3.3 dB.

Use the REL REF. control to set the meter at any convenient reference (0 dB for example) to make relative readings easier. When the REL. REF. control is in the fully counterclockwise CAL position, it has no effect on meter accuracy.

3–44. AC TO DC CONVERTER.

3–45. Follow all the turn on steps given in paragraphs 3–29 thru 3–32 for AC voltage measurements.

3–46. Connect the DC output binding posts on the rear panel to a dc measuring device such as a DVM, chart recorder limit controller etc. The dc measuring device must have a high input resistance. The DC output resistance of the voltmeter is approximately 500 Ohms. If it is loaded the converter DC OUTPUT signal will be inaccurate. A screwdriver accessible DC Adjust control (R247) on the rear panel is available to exactly set full scale dc output voltage and match it to the dc measuring device. The output is short circuit protected.

3–47. The DC output is a 0 to 1 volt dc signal proportional to the percentage meter deflection which, of course, is proportional to the average of the ac input signal. The dc output is not affected by the setting of the REL REF. control. In the 3056A DC output is 1V at full scale. In the 3055A the DC output is 1V at a reading of 1000 (full range) and 2V at a reading of 1999 (full scale).

3–48. WIDEBAND AC AMPLIFIERS.

3–49. The 3055A series of voltmeters provide either one or both ac amplifier outputs of 150 mV from 50 Ohms and

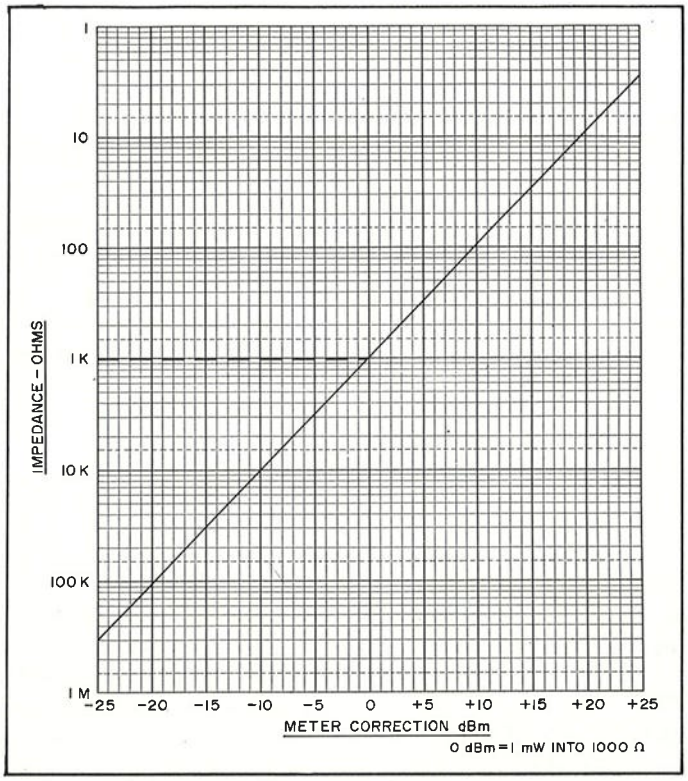


Figure 3–5. Impedance Correction Graph

1 V from 600 Ohms (open circuit). A BNC connector is provided for each output. Check specifications and the rear panel of your instrument to see which one or if both are supplied. The AC Amplifier may be used as a preamplifier for oscilloscopes, digital counters, limit controllers, etc.

3–50. Follow all the turn on steps given in paragraphs 3–29 thru 3–32 for AC Voltage measurements.

3–51. Connect the signal to be amplified to the INPUT BNC Connector J1.

3–52. It is permissible to FLOAT the instrument for amplifier operation and to use external dc power or internal battery operation. The shells of the INPUT BNC connector and the AC Amplifier BNC output connectors are electrically connected together. DO NOT use FLOAT mode on the 100 μV thru 10 mV ranges.

3–53. Observe the same precautions to reduce measurement errors as in voltmeter operation. It is even more desirable in AC Amplifier mode to break the ground loop earth connection through the use of isolating NEMA power cable ground adapters (Ballantine Part Number 31100750) on the oscilloscope, digital counter or other instrument for which the 3055A is used as a preamplifier. Keep input and output leads as short as possible. Shield the input and output leads of the voltmeter to minimize pick up. Keep maximum separation between input and output leads to minimize possible regenerative feedback and oscillations.

3–54. No special consideration need be given to the dc output which may always be used independently of the ac amplifier operation. Nevertheless, it is desirable to place a non-shorting shield cap (Ballantine Part Number 48033250) over the unused amplifier output BNC connector. If both 50 Ω and 600 Ω outputs are provided they may be used to provide separate outputs simultaneously. If both are used and high amplification is employed, use extreme care with input/output shielding and ground currents. Avoid common ground paths which may cause oscillations at higher frequencies.

3–55. The gain of the amplifier depends on the RANGE selection and whether the 50 Ohm or 600 Ohm output is used. The RANGE multiplier toggle switch changes gain in the AC amplifier mode. The open circuit full range output voltage is 150 mV for the 50 Ohm output and 1 Volt for the 600 Ohm output. Table 3–4 shows the ac amplifier gains for each RANGE setting.

3–56. USING THE INSTRUMENT TO 10 KILOVOLTS.

3–57. High Voltage AC Probe Model 1301A.

3–58. The 1301A High Voltage AC Attenuator Probe is used for measurements up to 10,000 volts rms (sinusoidal); or 14 kV peak. The probe is a capacitive divider with a division ratio of 10,000 to 1 (80 dB). The 1301A has a usable frequency response from 10 Hz to 6 MHz.

TABLE 3–4. AC AMPLIFIER GAIN

RANGE	GAIN	
	50 OHM OUTPUT	60 OHM OUTPUT
100 μV	+64 dB	+80 dB
1 mV	+44 dB	+60 dB
10 mV	+24 dB	+40 dB
100 mV	+ 4 dB	+20 dB
1 V	–16 dB	0 dB
10 V	–36 dB	–20 dB
100 V	–56 dB	–40 dB
100 V	–76 dB	–60 dB

3–59. To use the 1301A Probe, set range to 100 mV, or 1 volt to read 1 kV full range (1.999 kV full scale on the 3055A) or 10 kV respectively.

WARNING

ALWAYS CONNECT THE GROUND LEAD TO THE CIRCUIT UNDER TEST BEFORE CONNECTING THE HV PROBE. FAILURE TO OBSERVE THIS PRECAUTION WILL APPLY FULL HIGH VOLTAGE TO THE INSTRUMENT AND MAY NOT ONLY RESULT IN INSTRUMENT DAMAGE BUT MAY CAUSE A SERIOUS PERSONNEL HAZARD. ALWAYS CONNECT THE GROUND LEAD FIRST AND PERMANENTLY WHEN USING THE HIGH VOLTAGE PROBE. HANDLE THE PROBE ONLY AT ITS HANDLE AND AVOID CONTACT WITH THE FLASH GUARD AND TIP AREA.

3–60. To calibrate the 1301A probe, simply unscrew the probe tip to provide access to the calibration adjustment screw. Connect the probe to the V–Ω and COMMON connectors and set the DMM to AC and V. Set range to 100 mV. Apply 1 kV at 1 kHz to the probe from a voltage calibrator such as the Ballantine 421A. Adjust the probe calibration until the instrument reads 1 ± 1%.

SECTION 4
PRINCIPLES OF OPERATION

4–1. INTRODUCTION.

4–2. The 3055A series instruments are solid state average responding voltmeters calibrated in rms of a sine wave. The instrument also may be used as a wide band amplifier and as an ac to dc converter. Figure 4–1 provides a simplified block diagram used for the following discussion.

4–3. When the input attenuator RANGE switch A1S1 is in any of the first four positions (from 100 μV thru 100 mV), the input signal is not attenuated but is directly applied to input FETA1Q101. A1R103, A1C103, and A1R104 act as a voltage overload protection network in conjunction with the low capacity protection diodes monolithically incorporated in A1Q101. The remaining four positions of the RANGE selector switch A1S1 (from 1V to 1000V) insert a 1000 to one (60 dB) attenuator. On the 1 kV range A1R152 and A1R153 provide an additional 10:1 (20 dB) attenuation. The low frequency attenuation ratio is adjusted at 1 kHz by A1R106 while the high frequency attenuation ratio is adjusted at 100 kHz by A1C104. The attenuator is properly shielded and high voltage rated components are used to avoid breakdowns or changes in calibration with voltage overloads.

4–4. The signal from the input attenuator is supplied to the input amplifier. This amplifier is an impedance converting amplifier with a voltage gain of approximately 30 set by feedback resistors A1R126, A1R127 and capacitor A1C115. When the RANGE selector switch A1S1 is in the 100 μV, and 1000 V position a different feedback network consisting of A1R117 and A1C111 is used to reduce the voltage gain by ten to one (20 dB) to approximately 3. The negative feedback is used to stabilize the amplifier and assure calibrated gain and frequency response over extended environments, components changes and long recalibration intervals. The high input impedance is provided by a protected dual gate MOS FET A1Q101 which assures low noise, excellent bandwidth and an entry point for dc stabilization. The amplifier is dc coupled throughout, which assures fast recovery from input overloads and ideal low frequency performance. The input amplifier has excellent linearity to avoid introduction of harmonic distortion at higher signal levels and its low output impedance is matched to drive the post attenuator.

4–5. The post attenuator attenuates the output voltage from the input amplifier. See Table 4–1 for details of attenuation vs. RANGE switching. A1R132 adjusts the first step accuracy of the post attenuator (1 mV and 1 V ranges) to compensate for the output impedance of the input amplifier. The post attenuator is a ladder type constant impedance attenuator. Its characteristic impedance is nominally 500 Ohms and ranging accuracy is maintained with 0.1% precision fixed resistors. A1R133 maintains constant impedance in the straight thru position while fixed capacitors A1C131 and A1C127 maintain constant bandwidth. Full scale voltage output from the post attenuator is nominally 3.3 mV rms in the 100 μV Range and 33 mV in all other Ranges.

4–6. The output amplifier is a high gain dc coupled dc feedback amplifier. The meter bridge is in the ac feedback path and is dc coupled to the output of the output amplifier. It converts the ac input signal to a dc voltage proportional to the absolute average value of its ac input since the output amplifier presents a high impedance to the meter bridge. The meter bridge differentially drives the meter amplifier. A1R222 adjusts the dc level of the output amplifier so that the meter bridge drive is centered about the circuit ground. The output amplifier has high feedback and excellent gain – bandwidth so that no gain or frequency adjustments are required.

4–7. The meter amplifier is a monolithic operational amplifier (A1U201). RANGE switch A1S1 selects X10 gain in the 100 μV position inserting the proper feedback resistor. The amplifier is a low pass filter to eliminate remaining ripple from the meter bridge and to set the meter response time. A1C222 is the integrating capacitor. Since the meter amplifier is essentially a gain switched dc amplifier with excess feedback, it uniquely contributes to the performance of the instrument by isolating the meter from the meter bridge. The full scale output of the meter amplifier is nominally 2 volts dc and its current capability is sufficient to drive a rugged, high torque 1 mA meter in the 3056A as well as the dc output whose amplitude is set by A1R247. In the 3055A the impedance of the digital meter is controlled by R805.

4–8. A three stage AC output amplifier derives its input from the buffered input of the output amplifier. It provides full scale and open circuit 150 mV rms to a 50 Ohm output and one volt rms to a 600 ohm output counter.

4–9. The ac power supply is a transformer input bridge rectifier circuit feeding two 12 Volt monolithic integrated circuit power supply regulators. The latter are wired in series and their junction is circuit ground so as to provide very well regulated, short circuit proof, plus and minus 12 Volt power supplies.

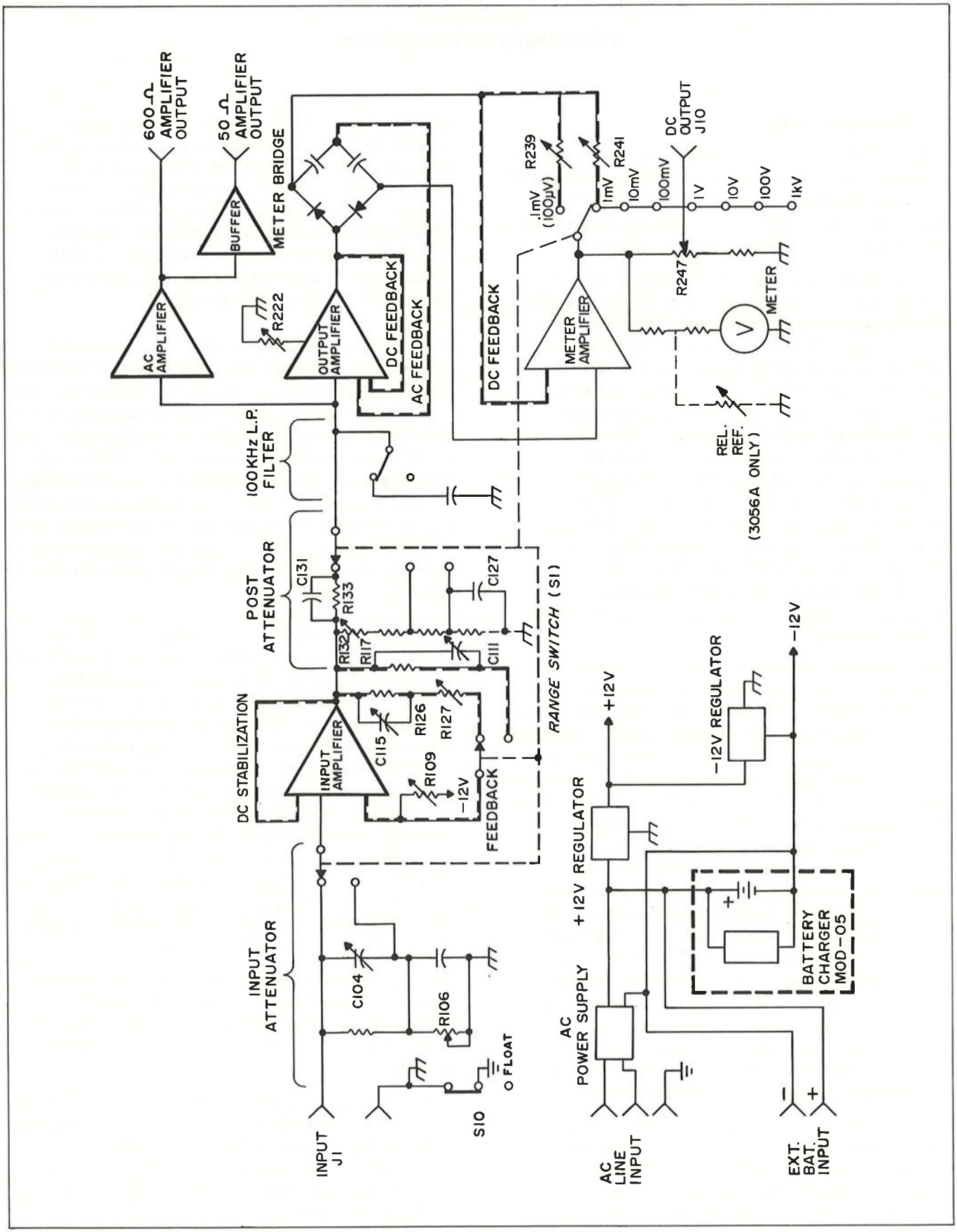


Figure 4–1. Simplified Functional Block Diagram

TABLE 4–1. ATTENUATION vs RANGE SWITCHING.

Range	Input Attenuator		Input Amplifier Gain dB	Post Attenuator		Meter Amplifier Multiplier	Total Attenuation dB	
	Ratio	dB		Ratio	dB		3045A 3046A	3015 3015A MOD-91, 92
100 μV	1	0	0	1	0	X0.1 (+20dB)	0	N/A
1 mV	1	0	0	1	0	X1	–20	0
10 mV	1	0	0	0.1	–20	X1	–40	–20
100 mV	1	0	–20	0.1	–20	X1	–60	–40
1 V	1000	–60	0	1	0	X1	–80	–60
10 V	1000	–60	0	0.1	–20	X1	–100	–80
100 V	1000	–60	–20	0.1	–20	X1	–120	–100
1000 V	10000	–80	–20	0.1	–20	X1	–140	–120

4–10. CIRCUIT DESCRIPTION.

[See Figures 6–1 through 6–3]

4–11. Input Attenuator.

4–12. The input attenuator is an 8 position RANGE switch (A1S1) which is inserted and soldered into the main assembly board (A1). The initial 4 positions are straight thru while the remaining 4 steps provide attenuation by 1000 (–60 dB). On the 1 kV range an extra 10:1 (–20 dB) of attenuation is provided. All components in the input circuit are mounted in Teflon or diallylpthalate to optimize the performance of the 10 Megohm attenuator in severe environments and high humidity. See paragraph 4–3 for additional details.

4–13. Input Amplifier and Attenuators.

4–14. The input amplifier is located on the main assembly board A1 and it (along with the attenuators) has component designators in the 100 number sequence. The input amplifier is a FET input feedback amplifier which matches the high impedance of the input attenuator to the relatively low impedance of the post attenuator. Feedback is switched by the RANGE switch A1S1 so as to provide an additional 20 dB of attenuation and thereby limit the dynamic drive required at the post attenuator. Over-voltage protection is provided by A1R103 and A1R104 as well as by the 60 dB RANGE attenuator inserted in the 1 Volt thru 1000 Volt ranges. These components act to drop the voltage limited by breakdown diodes monolithically incorporated in the input MOS FET A1Q101.

Note

If large continuous overloads or high voltage high frequency overloads endanger the voltmeter beyond its specified overvoltage rating then A1R104 may be replaced by a 1/16 Ampere miniature fuse (Ballantine Part Number 19100160) to protect against destructive overloads.

4–15. A dual gate MOS FET (A1Q101) is used in the input stage because of its protected high impedance input, low noise, good frequency response, and its ability to accommodate a dc stabilization input that is fully separated from the high impedance signal input. The FET is buffered by emitter follower A1Q102 which feeds differential amplifier A1Q103 and A1Q104. A1Q104 supplies a dc source for emitter feedback resistor A1R121 and its collector provides the dc stabilization voltage for FET A1Q101. A1Q103 feeds output transistor A1Q105. A1R109 adjusts the dc operating point of the input amplifier so that the collector of A1Q105 provides essentially zero voltage across the switched feedback resistors A1R117 and the combination of A1R126 and A1R127. Solid heavy lines on the schematic show signal paths while broken lines show the feedback paths.

4–16. The post attenuator is a ladder attenuator of 500 Ohms characteristic impedance. It is ac coupled from the input amplifier by A1C134 to avoid meter transients when switching between RANGE steps. See paragraph 4–5 for additional details.

4–17. A Low Pass Filter may be switched in by A1S4. It consists of capacitor A1C122 which effectively reduces the high frequency bandwidth of the instrument to 100 kHz (–3 dB).

4–18. Output Amplifier and Meter Bridge.

4–19. The output amplifier is a high performance feedback stabilized amplifier which operates at a fixed gain on all ranges. It is located on main assembly board A1 and has component designators in the 200 number sequence. Its input is a differential amplifier consisting of A1Q201 and A1Q202. Signal enters at the base of A1Q201 while dc feedback is applied to the base of A1Q202 and ac feedback from the meter bridge is fed into the emitter of A1Q201 and buffered by emitter follower A1Q203 which feeds the base of A1Q204. A1Q204 and A1Q205 comprise a differential amplifier. The dc level for the entire output

amplifier is adjusted by A1R222 which sets the base voltage on A1Q205. Signal from the collector A1Q206 drives the average responding meter bridge. Very high source impedance assures absolute average response. It is achieved by the high gain bandwidth of the output amplifier and by including the meter bridge in the ac feedback loop.

4–20. The meter bridge is a typical two diode bridge rectifier. It is driven from a high impedance source and provides a dc output proportional to the absolute average of the input ac waveform.

4–21. Diodes A1CR201 and A1CR202 are hot carrier diodes which permit excellent high frequency performance beyond 20 MHz. They have negligible storage time and therefore induce inconsequential phase shift in the ac feedback to the output amplifier. A1R231 and A1R232 each develop approximately 150 mV forward bias to linearize the bridge for small input signals. A1R234 and A1R235 provide loading for the bridge as well as balance to circuit ground. These load resistors further flatten frequency response. Signal output from the meter bridge is taken from the output of the diodes.

4–22. The meter bridge is included in the ac feedback path of the output amplifier to assure an effective high driving impedance for the rectifier bridge and therefore to make it average responding. The very high feedback factor optimizes rectification linearity over the full frequency and dynamic range. Feedback is taken from the junction of bridge capacitors A1C217 and A1C218.

4–23. Meter Amplifier.

4–24. The meter amplifier is a high performance monolithic integrated circuit operational amplifier (A1U201). It is driven differentially from the two balanced outputs of the meter bridge. The meter amplifier is controlled by negative feedback applied from the amplifier output to its inverting input. The feedback and input resistors are sufficiently large that the meter amplifier presents negligible loading to the meter bridge to assure optimum rectification linearity.

4–25. The response time of the voltmeter is controlled in the meter amplifier by making it an integrating amplifier. A1C222 controls the integration time constant and is placed in the negative feedback loop of the meter amplifier.

4–26. The feedback in the meter amplifier is switched by RANGE switch A1S1 to provide 10 gain on the 100 V range thru a feedback controlled gain change of 20 dB. A1R241 adjusts the X1 gain while A1R239 sets the X10 gain (+20 dB) on the 100 μV range.

4–27. The input bias voltage offset of A1U201 and the meter bridge is nulled by A1R243 when the RANGE switch is set to all ranges of 1 mV to 1 kV and by A1R257 when set to 100 μV. These controls permit adjustment of down scale linearity and tracking.

4–28. Using an op-amp to buffer the meter movement from the bridge rectifier greatly improves the linearity and dynamic range of the bridge rectifier. It also makes available ample driving power for a rugged high torgue 1 mA taut-band meter movement in the 3056A and a comparatively low impedance dc converter output which is fully independent of the meter and the other AC amplifier outputs.

4–29. To improve downscale linearity a feedback hold off circuit increases gain in the lower quarter of the 100 μV range. ACR203, A1R255 and A1R256 comprise the feedback holdoff which functions until the meter amplifier output voltage increases and A1CR203 conducts.

4–30. To avoid meter needle slam and meter overloads which might damage the meter movement or deteriorate meter linearity or calibration, Ballantine has engineered a unique circuit which automatically disconnects the meter movement from the meter amplifier when overloads exceed 50% above fullscale (i.e. 1.5 mA). A1CR801 simply disconnects when the voltage drop across A1R801 begins to back-bias the diode. This protective circuit is not required in the 3055A digital voltmeter.

4–31. A1R802 and A1803 have a resistance many times that of the meter movement and thereby act as a constant current source to the meter which eliminates temperature related calibration errors in the copper wire coil in the 3056A meter. A1CR802 is forward biased by A1R802 to compensate for forward drop in output diode A1CR801. It assures that the meter is at electrical zero when no signal is applied on those ranges above 100 mV where amplifier noise does not cause any meter deflection.

4–32. The DC converter output at J10 is taken from the meter amplifier and adjusted to 1 Volt full scale by A1R247.

4–33. The 3056A linear dB scale meter incorporates the REL. REF. control. This control (A1R601) operates as a shunt to reduce drive only to the meter and continuously varies calibration by as much as –3.3 dB.

4–34. AC Output Amplifier.

4–34. The AC output amplifier provides a 50 Ohm output which provides 150 mV rms (open circuit) and a 600 Ohm output providing at least 1 Volt rms (open circuit). The AC amplifier component reference designations are in the 300 number sequence. These components are also located on the main assembly board A1.

4–35. The ac signal available at the free collector of A1Q202 in the output amplifier is buffered by emitter A1Q303. (Some instruments omit this buffer while others may omit all or part of the ac output amplifier system.) A1C303 couples the signal to amplifier A1Q302. A1R310 adjusts the operating level of A1Q302 and thereby sets the zero volts output level of the 50 Ohm amplifier output J2. A1R305 in the emitter of A1Q302 sets the gain of both ac

outputs to exceed the minimum limit in the 1 mV thru 1 kV ranges. The instruments in this series are provided with A1S1, A1R309, and A1C309 which permit a +20 dB (X10) gain magnification of the ac output amplifiers to provide full output of +80 dB gain on the 100 μV RANGE.

4–36. Signal taken from the tap in the collector resistors of A1Q302 is ac coupled thru A1C301 to J3, the 600 Ohm output. Signal taken from the collector of amplifier A1Q302 is fed to the base of emitter follower A1Q301 and after attenuation and leveling by A1R303, A1R302 and A1R301 is applied to J2, the 50 Ohm output. Both outputs are fully independent, each is short circuit proof and both may be used at the same time.

4–37. Power Supply.

4–38. The power supply operates from external ac power, external dc battery or an optional internal battery.

4–39. The power supply provides +12 Volts and –12 Volts. All components for the power supply are located on the main assembly board A1 and its component designators are in the 400 sequence except components in the single digit series which identify parts location on the rear panel assembly A2. A1U401 and A1U402 are monolithic integrated circuit power supply regulators which incorporate their own voltage reference as well as thermal and short circuit protection. The +12 Volt regulator (A1U401) provides regulated power to the –12 Volt regulator (A1U402).

4–40. External dc battery power is coupled directly to the filter at the input of the regulators. The external battery voltage must be greater than 28 Volts and less than 44 Volts. The battery must float in respect to circuit ground. Diodes A1CR505 and A1CR506 protect the circuitry against reversed polarity of the external battery. ON-OFF switch S5A disconnects the external battery when power is turned off.

4–41. AC power input is through power transformer A1T401. Its dual primaries permit 115 Volt (parallel connection) or 230 Volt operation (series connection) as selected by switch A1S6. Some instruments in this series are provided with a multi-tap primary power transformer for 100/120/220 Volt operation. See schematic Figure 6–3 for connections and further details. The input to A1T401 is protected by fuse A2F1 and line filter A2C1. Resistor A2R1 limits line surge effects and may be removed to improve low line voltage regulation in areas where the power line voltage range is normally between 85 Volts and 110 Volts rms. The output of A1T401 is rectified by diode bridge A1CR401 and the resultant dc is filtered by A1C401, A1R401 and A1C402.

CAUTION

Line power is always connected to A1T401 even though the power switch is OFF. Remove the power cord whenever servicing the instruments to avoid possible personnel hazard.

4–42. Option 05 provides internal rechargeable battery operation. The battery and charger components are located on main assembly board A1 and the component designators are in the 500 sequence. A1B501 is a nickel-cadmium (24 cell) 28 Volt battery. It is charged at a rate determined by the emitter resistance of A1Q501. A1R502 is adjusted to provide 60 mA to the battery when switch A1S501 is in the FAST position. When switch S501 is in the NORM position A1R503 is inserted to limit battery trickle charge to about 10 mA. The power switch A1S5 must be ON for all battery charging. The internal battery may be charged from ac line power or an external dc source.

Some instruments in this series incorporate a three position rotary power switch on the front panel. This switch provides ON OFF and BAT CHGE positions. When this rotary switch is used rear panel switch S501 is deleted.

4–43. Digital Display – 3055A only.

4–44. A 3½ digit 2 volt full scale dc panel meter (DPM) manufactured by Ballantine Laboratories is used to provide digital readout. An instruction manual for the DPM is also provided with each 3055A. The DPM is mounted on the front panel and on assembly board A2.

4–45. The DPM is powered from 115 Volts AC only. For 230 volt operation it derives its voltage from one primary of the power transformer A1T401 which then serves as an auto transformer. Relay A2K1 is activated by the internal dc power supplies and serves as the on-off ac power switch for the DPM. This is required since A1T401 is always connected to J5 the ac power receptacle.

4–46. Although the DPM incorporates zero and span (full scale adjust) controls accessible by removing the front panel snap-off bezel an additional control A2R100 is provided too as an internal coarse meter calibration adjustment. A2R100 obtains its signal through A2R101 from the output of meter amplifier A1U201.

4–47. Decimal points for the DPM are automatically positioned by rotary switches in the RANGE switch A1S1. Deck A2S1G provides the switch and is attached to printed wiring board assembly A2.

4–48. To remove printed wiring board assembly A2 disconnect ac or dc power and simply remove the hold down screw near the DPM. Then slide A2 toward the rear of the instrument and disengage the DPM connector and switch deck A2S1G. Assembly A2 may then be positioned out of the way to provide simple access to all of A1. Be careful not to ground the terminal pins or the instrument may be damaged when power is applied. Note that ac power mains voltage appears on the terminal pins and use proper caution to avoid personnel shock hazard.

Note

Access holes are provided in A2 to provide adjustment of all controls located on A1 so that full calibration may be performed with A2 in place.

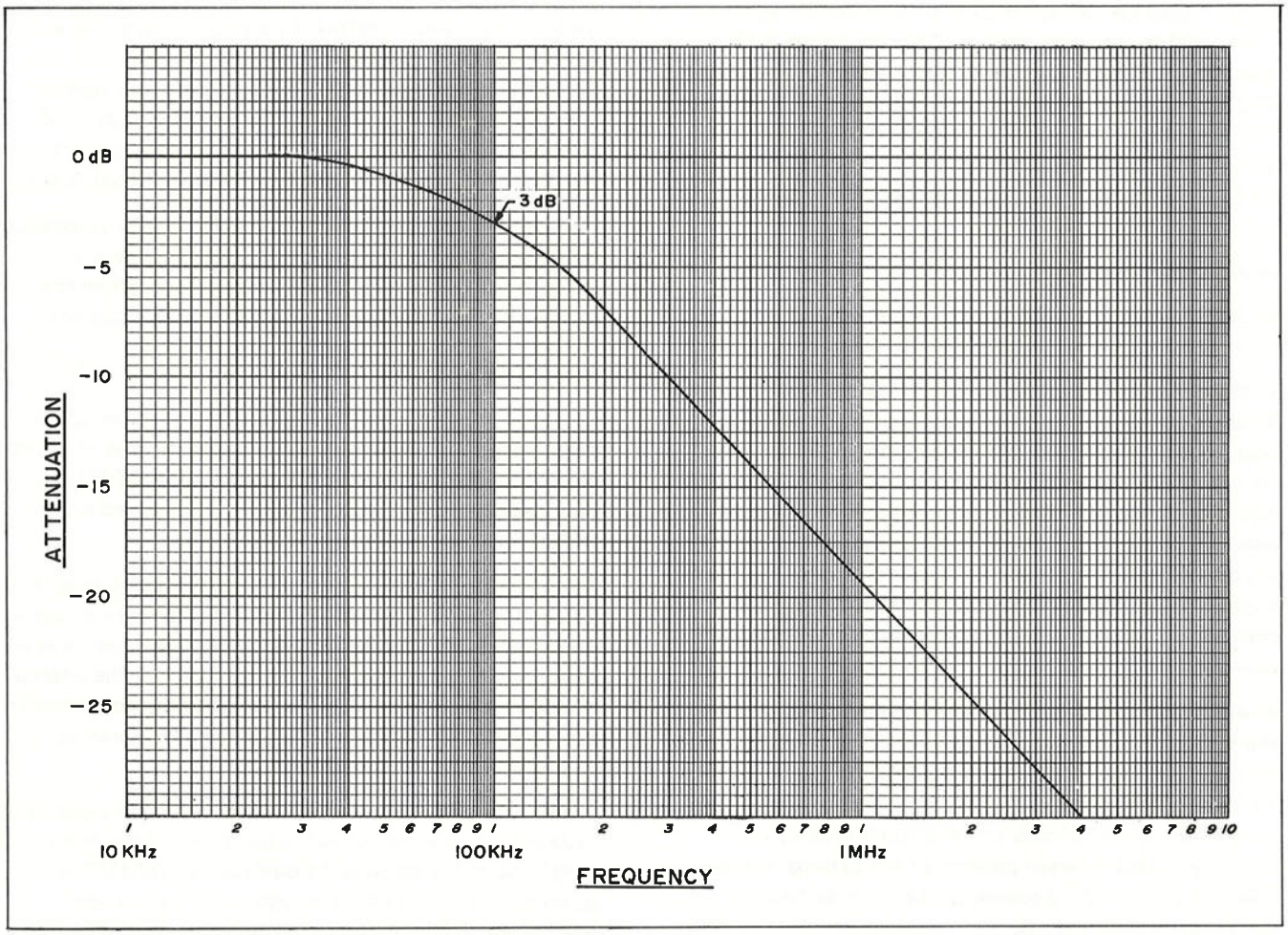


Figure 4–2. 100 kHz Filter Response

SECTION 5
MAINTENANCE AND CALIBRATION

5–1. INTRODUCTION.

5–2. This section contains information required to maintain the 3055A series voltmeters within specifications. The following paragraphs detail:

a. Performance Assurance checks

b. Calibration Procedures

c. Fault Finding (Troubleshooting) details

d. Preventive Maintenance

5–3. The 3055A series of instruments are designed with premium components and like other Ballantine instruments will provide many years of satisfactory service. Ballantine recommends that performance assurance checks and preventive maintenance procedures be performed as follows:

a. Routine Laboratory Service – Every 6 months or 1000 hours of use whichever comes first.

b. Service in the field or in extended environments – Every 90 days or 350 hours of use whichever comes first.

Full NBS traceable calibration should be performed once a year. Normally the user will provide recalibration services in his plant. If required, Ballantine Laboratories will gladly provide this calibration service at our Boonton, N.J. plant for a nominal charge.

5–4. REQUIRED TEST EQUIPMENT.

5–5. Table 5–1 provides a list of required test equipment needed to properly check, calibrate and maintain the 3055A series voltmeters. Equivalent test equipment meeting all the minimum requirements may be substituted if the recommended items are not available.

5–6. METER ZERO ADJUST.

5–7. DO NOT adjust the mechanical meter zero setting on the 3056A and other instruments with a linear dB scale since serious miscalibrations and non-linearities can result. Zero the 3055A digital meter with its front panel zero adjust ONLY when the digital panel meter signal input leads are shorted.

5–8. PERFORMANCE ASSURANCE CHECKS.

5–9. The performance assurance checks are "in cabinet" tests that compare the 3055A series with the applicable specifications. A test record form is provided for these instruments. The form included in this manual as Form 5–1 may be duplicated to provide a permanent record of incoming inspection date or of periodic performance assurance checks. These checks should be conducted in their entirety and in order listed below before any attempt is made to calibrate the instrument.

5–10. CALIBRATION ACCURACY CHECK.

5–11. The basic accuracy tests are performed at 1 kHz. A sine wave source calibrated in rms is used as a precisely calibrated input signal to the voltmeter. For the preferred test set up see Figure 5–1. The Ballantine 421A AC/DC voltage calibrator has a basic accuracy of 0.2% at 1 kHz rms and exceptional waveform purity with less than 0.3% harmonic distortion. All meter ranges from 100 μV to 1 kV full scale may be calibrated with the 421A calibrator.

Note

For optimum performance let the 421A calibrator and the 3055A series voltmeter under test warm-up for at least one hour.

5–12. Prior to performing accuracy tests connect the test set-up of Figure 5–1 and make the following line voltage checks to be certain that the 3055A series voltmeter has a fully regulating power supply.

a. Set line voltage auto transformer to 115 V (or 230 V if applicable). Measure line voltage with a precision true rms ac voltmeter.

b. Set voltmeter to 1 millivolt full scale sensitivity.

c. Apply 0.9 mV rms of 1 kHz sine wave from the ac calibrator to the voltmeter.

d. Note that the voltmeter indicates a meter reading of nominally 0.9 mV.

e. Vary the power line input to the voltmeter to 103 volts (or 206 Volts) and observe that the meter reading has not changed.

f. Vary the power line to 127 volts (or 254 volts) and observe that the meter reading has not changed.

g. Reset the line voltage to mid line of 115 volts (or 230 volts, or 100 volts as applicable. See paragraph 4–42). If any of the above tests can not be satisfactorily performed then further maintenance and full recalibration is required.

5–13. To check full scale calibration of each voltmeter RANGE proceed as follows:

a. Use the test set up of Figure 5–1 and position the 421A calibrator to 1.000 mV 1 kHz rms.

b. Set the 3055A series voltmeter to the 1 mV RANGE and note the tolerance listings of Table 5–2.

TABLE 5–1. REQUIRED TEST EQUIPMENT

Instrument Type	Recommended Model	Specifications
AC Calibrator	Ballantine 421A with 1421 Deviation Calibrator	1 kHz RMS output 1 mV to 1 kV with 4 digit resolution to 1 μV. 0.3% maximum harmonic distortion. Accuracy 0.2% of reading
Test Oscillator Low Frequency	Wavetek 110 or equivalent	1 Hz to 100 kHz Sine wave source 50 Ohm output to 1 V RMS
Test Oscillator Mid Frequency	H-P 651B or 652A or equivalent	10 Hz to 10 MHz 50 Ohm output to 1 V RMS Distortion ± 0.25%
Test Oscillator High Frequency	Tektronix 191 or equivalent	50 kHz and 350 kHz to 100 MHz 50 Ohm output to 2 V RMS and 5 V peak to peak
Digital Multimeter	Ballantine 3028A	DC: 1000 mV to 1 kV Full Scale Accuracy 0.25% Input impedance 10 MΩ Current 10 nA to 2 Amp AC: 1000 mV to 1000 V Full Scale Accuracy 1%, 40 Hz to 100 kHz Current 10 nA to 2 Amp Ohms: 1000 Ohms Full Scale with 0.1 Ω resolution to 10 MΩ in 6 decade ranges and LO Ω for incircuit resistance measurements.
Thermal Converter	Ballantine 1394A-1 or 1600A AC/DC Auto-balance Transfer Standard	Input: 0.5 V to 1 V Frequency Response: DC and 5 Hz to 30 MHz Impedance: 200 Ω per Volt AC/DC Transfer Accuracy: 0.1% to 1 MHz 0.2% to 20 MHz Output: 7 mV DC with 1 Volt (5mA) input Certified: NBS traceable
Lindeck Potentiometer (DC null Meter and bias supply)	Ballantine 3620A or H-P 3420B	Bias Range: 10 mV Accuracy: 2% of F.S. Resolution 1 microvolt or 10 ppm referred to Thermal Converter output
Termination	Ballantine 12630A	50 Ohms, 1 W, BNC to BNC feedthru
Adapter (2 ea.)	Ballantine 12620A or equivalent	BNC female to GR-874

TABLE 5–1. REQUIRED TEST EQUIPMENT (continued)

Instrument Type	Recommended Model	Specifications
Adapter (2 ea).	Ballantine 12625A or equivalent	BNC male to GR-874
"T" Adapter	Ballantine 10186A or equivalent	GR-874 "T"
Coaxial Attenuator (2ea.)	Ballantine 12626A or equivalent	50 Ohm, GR-874 20 dB DC to 1 GHz Flatness 0.1% DC to 100 MHz
Coaxial Attenuator	Ballantine 12627A or equivalent	50 Ohm GR-874 10 dB DC to 1 GHz Flatness 0.1% DC to 100 MHz
Coaxial Attenuator (3 ea.)	Ballantine 12628A or equivalent	50 Ohm GR-874 3 dB DC to 1 GHz Flatness 0.1% DC to 100 MHz
Resistors	Ballantine P/N 12125000A or Test Fixture Ballantine 12635A Ballantine P/N 12122670A	100 kΩ, ± 1% RN-60 499 Ω, ± 1% RN-60
True RMS Voltmeter	Ballantine 323L True RMS Voltmeter	Frequency Range: 5 Hz to beyond 20 MHz (3 dB beyond 40 MHz) Sensitivity: 1 mV full scale to 300 V full scale Battery Operation
AC/DC Transfer Standard (Auto balancing)	Ballantine 1600A with Dana 5500 or equal	.25 V to 1 kV in 12 ranges Null resolution: 10 ppm Frequency response: 0.01% dc to 20 kHz 0.05% to 100 kHz 0.05% to 1 MHz 0.75% to 10 MHz 5.00% to 30 MHz Certification: NBS traceable AC/DC difference with 6 digit dc digital voltmeter. 100 mV F.S. to 1 kV F.S. Accuracy ± 0.01%: NBC traceable calibration.

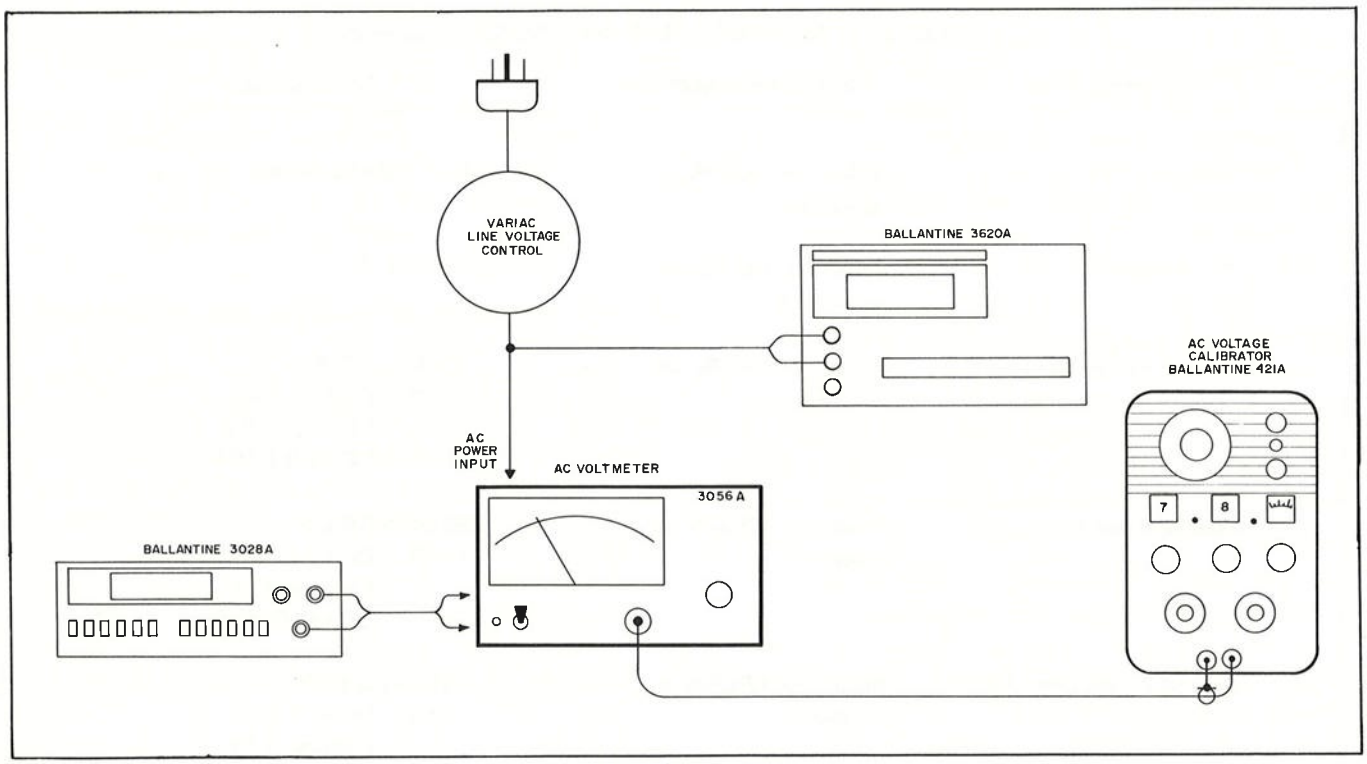


Figure 5–1. Accuracy Test Setup

TABLE 5–2. 1-kHz CALIBRATION AND RANGING TOLERANCE CHECK

Calibrator Setting		Voltmeter		
1 kHz RMS	F.S. Multiplier	Range	Meter % of Reading	DC Output [Volts]
1.000	1 mV	100 μV	1 ± 1%	99 to 1008
10.000	1 mV	1 mV	1 ± 1%	99 to 1008
3.000	10 mV			
10.000	10 mV	10 mV	1 ± 1%	99 to 1008
3.000	100 mV			
10.000	100 mV	100 mV	1 ± 1%	99 to 1008
3.000	1 mV			
10.000	1 V	1 V	1 ± 1%	99 to 1008
3.000	10 V			
10.000	10 V	10 V	1 ± 1%	99 to 1008
3.000	100 V			
10.000	100 V	100 V	1 ± 1%	99 to 1008
3.000	1 kV	1 kV	1 ± 1%	99 to 1008

c. Set the 421A calibrator deviation calculator (Model 2421) to zero and note that the DVM reading of the dc converter output voltage is within the tolerances listed in Table 5–2 for the 1 mV range. If not adjust the deviation calculator knob a maximum of ±0.2% to bring the voltmeter under test into calibration by nulling out the possible 0.2% error in the calibrator. Should this bring the instrument into the required tolerances, rotate the outer dial of the deviation calculator to zero. Set the deviation calculator scale to the adjusted knob position.

d. Adjust the deviation calculator until the 3055A series meter reads precisely the applied voltage. Then read the deviation directly from the deviation calculator dial when checking the remaining full scale meter accuracies. Note that the outer ring dial of the deviation calculator has been set to its adjusted zero reference. Follow Table 5–2 for all accuracy specifications.

e. If a calibrator is used which has no percentage deviation adjustment capability, simply apply the full scale range input voltage called out in Table 5–2 and read meter error directly from the meter scale. If the calibrator has a percentage deviation range but no deviation null adjust (i.e., H-P 745A/746) simply proceed with the technique outlined above and see Table 5–2 for the 1 mV range meter accuracy. If required simply subtract the 1 mV range error from all other measured errors to obtain range tracking accuracies based on a normalized 1 mV range.

5–14. FREQUENCY RESPONSE CHECK. Check full scale, midscale and 1/3 scale tracking on the 3056A and 1000, 500 and 333 on the 3055A.

5–15. Frequency response for the 3055A series is based on the 1 kHz full scale response and all frequency response measurements are ratioed to the 1 kHz accuracy. Use of the ratio technique speeds measurements by avoiding an amplitude calibration set up at each of the various test frequencies.

5–16. To assure best accuracy, Ballantine recommends the use of thermal converters (Ballantine Series 1394A) to control flatness of input frequency to better than 0.5% from 5 Hz to 15 MHz. The 3055A Series voltmeters are calibrated from 5 Hz to 15 MHz and three signal sources are required to cover this range.

a. 5 Hz to 30 Hz – Function Generator

b. 30 Hz to 350 kHz – Audio Oscillator

c. 350 kHz to 15 MHz – Constant Amplitude Signal Generator

Note

The test oscillator must have very low distortion (less than 1%) when loaded by 50 Ohms and shunted by 30 pF and a 1394A thermal converter having input resistance of 200 Ohms per Volt. A thermal converter is true rms responding while the voltmeter is average responding and therefore reacts differently to distortion. Any distortion present in the test signal will create a calibration error. See paragraph 3–10.

5–17. The 3055A Series are wideband instruments calibrated from a 50 Ohm source impedance. It is important that the 50 Ohm feedthru termination be used directly at the input BNC connector (J1) of the voltmeter.

5–18. The signal generators used to measure frequency response must deliver 25 mA rms at 1 Volt output. This drives the thermal converter (5 mA full scale) and the 50 Ohm termination. To obtain low output levels, attenuate the 1 Volt (or 3 Volt) signal from the thermal converter with 50 Ohm constant impedance wide band resistive coaxial attenuators. See Figure 5–2 for the test equipment setup and Table 5–3 for attenuator pads to be used with each range.

TABLE 5–3
THERMAL CONVERTER AND ATTENUATOR PADS PER RANGE

Range	Thermal Converter	50 Ω Attenuator Pads
1 kV	1600A	None
100 V	1600A	None
10 V	1600A	None
1 V	1394A-1	None
100 mV	1394A-1	20 dB
10 mV	1394A-1	20 dB, 20 dB
1 mV	1394A-1	20 dB, 20 dB, 20 dB
100 μV	1394A-1	10 dB, 20 dB, 20 dB, 20 dB

5–19. Set up the frequency response test equipment per Figure 5–2. Use the 1 kHz 1 Volt calibrator as the signal source. Connect the thermal converter and voltmeter as indicated. Note that the dc output from the thermal converter is in the range of 6 mV to 8 mV. Permit the equipment to stabilize for at least one hour. Resolve the dc output of the thermal converter to a microvolt using the analog meter of the H-P 3420B Delta Volter (Lindeck potentiometer).

After warmup adjust the 1 kHz calibrator reference signal until the voltmeter and its DC output voltage read exactly full scale. Rebalance (null) the H-P 3420B. Maintain this null balance condition on the H-P 3420B throughout the tests for each range to assure constant input signal amplitude as frequency is varied. Adjust the signal source output amplitude to hold the null to within ±1 μV.

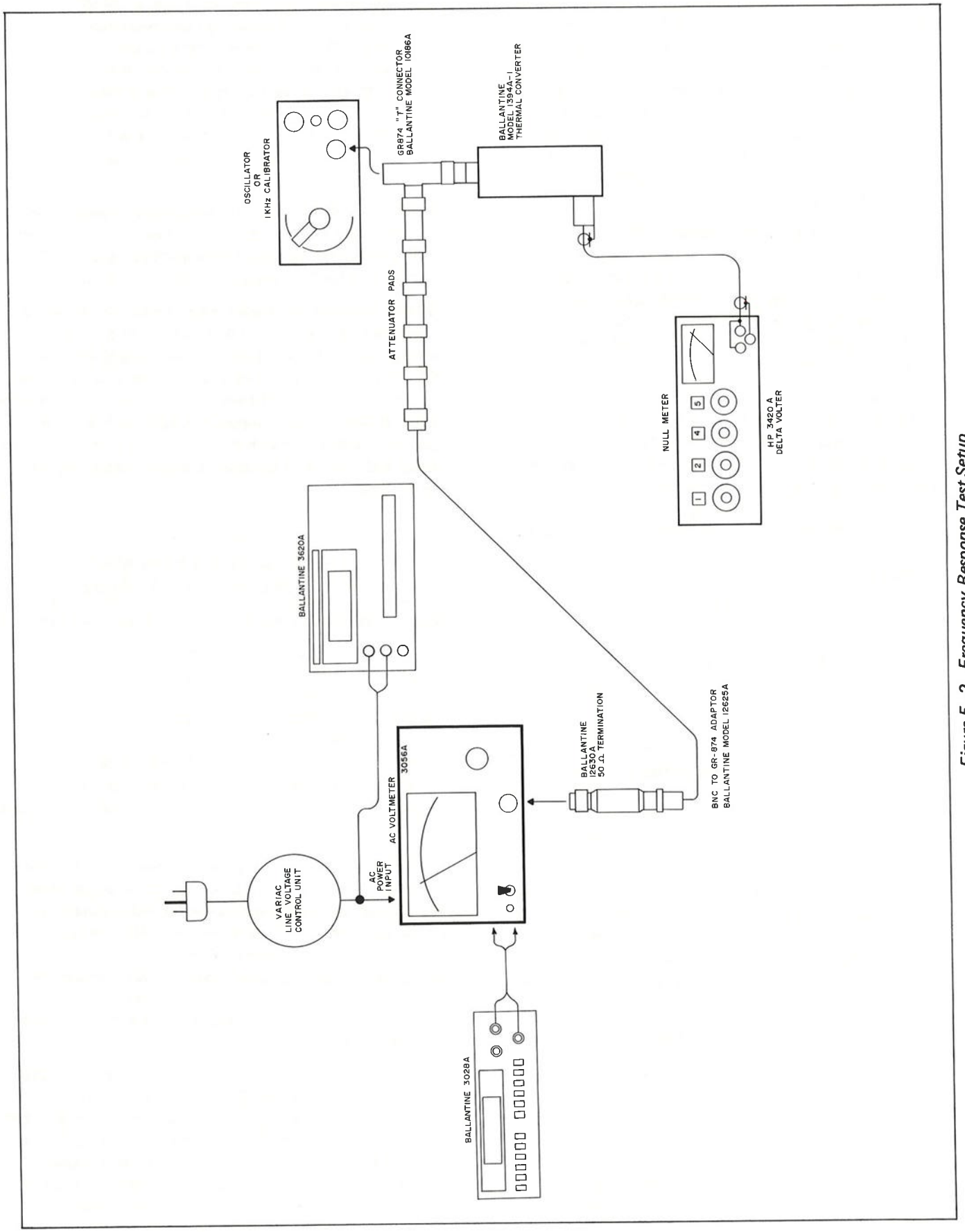


Figure 5–2. Frequency Response Test Setup

CAUTION

DO NOT over-voltage the thermal converter. Voltages in excess of the rated input voltage will destroy the thermoelement in the thermal converter.

5–20. Check the frequency of the 1 Volt range of the voltmeter as indicated in Table 5–4. Rebalance the null of the thermal converter with the 1 kHz reference at down scale settings of the voltmeter. Be sure to use a 3 dB attenuator pad when checking below half scale.

5–21. Add the required attenuator pads to lower the signal input to the voltmeter. On each range set the 1 kHz calibrator reference to exactly the required scale on the meter and DC output. Then normalize (null) the H-P 3420B. Proceed as indicated in Table 5–4.

5–22. This checks response and calibration at full scale mid-scale and 1/3 scale for tracking accuracy.

5–23. Normally it is sufficient to check the 1 Volt, 100 mV and 1 mV ranges. Other ranges may be checked at the users option and if the proper test equipment is available. Use signal amplifiers for the normally small signal output level of the oscillators. The H-P 230 and 745/6A are recommended above 10 MHz and to 100 kHz respectively. Do not exceed 3 times 10^8 Volt Hertz on the 1 kV range.

CAUTION

Always use great care when using thermal converters since any overload may destroy the thermoelement. Always use the following precautions:

Set test oscillator to minimum output amplitude before connecting or disconnecting.

Set test oscillator to minimum output amplitude before changing frequency range.

Maintain ground connections in the thermoelement dc output circuit to avoid over-voltaging (50 V peak) the junction between the thermoelement heater and couple. Even stray voltages coupled through body capacitance may otherwise breakdown the insulation within the thermoelement.

Never permit the test oscillator output (rms) to exceed the rating of the thermal converter.

5–24. ABSOLUTE CALIBRATIONS TRACEABLE TO NBS.

5–25. If absolute accuracy calibration is required use a Ballantine 1600A Autobalancing Transfer Standard with a precision DC voltmeter. Use the previous procedure involving the attenuator pads of Table 5–3 and the suggested signal sources. It will not be necessary to normalize the output of the thermal converter. Simply use the 1600A to directly measure the appropriate scale level amplitude settings at different frequencies. See Table 5–4. The 1600A may also be used in the "reverse" mode to set up exactly calibrated test oscillator output signals and error spreads of the voltmeter and its DC output checked against the accuracies of Table 5–4.

5–26. See Figure 5–3 for the test equipment setup using the 1600A Automatic Transfer Standard. This method provides transfer measurement accuracies of 0.01% with a resolution of 10 ppm. Use of the 1600A also permits the most rapid calibration of the 3055A Series voltmeters.

5–27. AC OUTPUT VOLTAGE CHECK.

5–28. A 600 Ω and a 50 Ω AC Amplifier output are provided on the 3055A and 3056A.

5–29. Connect test oscillator (HP651) with frequency range of 10 Hz to 10 MHz to the input BNC of the voltmeter. Use a 50 ohm feed thru termination.

5–30. Connect an AC voltmeter (Ballantine 3045A or 323) to the 50 Ω AC Output BNC Connector thru a very short (<6 inch) low capacity shielded cable. Set the voltmeter to the 100 mV range.

5–31. Set the voltmeter under test and the oscillator to the one volt range.

5–32. Adjust the amplitude of the oscillator for full scale deflection on the 3055 Series Voltmeter. The 50 Ω AC Output amplitude should exceed 150 mV rms over the frequency range of 10 Hz to 4 MHz and 135 mV rms to 10 MHz.

5–33. Set the 3055A series voltmeter RANGE switch to 100 μV and reduce the oscillator output amplitude to full scale meter deflection on the 3055A series voltmeter. The AC output should exceed 150 mV from 20 Hz to 2 MHz and 115 mV from 10 Hz to 10 MHz.

5–34. Remove the AC Voltmeter from the 50 Ω AC output BNC and re-connect it to the 600 Ω AC Output BNC. Set the voltmeter to the 1 Volt range.

5–35. Adjust the amplitude of the oscillator to provide full scale deflection on the 3055A series voltmeter 1 volt range. The 600 Ω AC Output amplitude should exceed 1 volt rms over the frequency range of 10 Hz to 4 MHz and 0.8 volts to 10 MHz. Repeat with the Voltmeter RANGE switch set to 100 μV and note that the output voltage is greater than 1 Volt rms from 20 Hz to 2 MHz and 0.75 Volts from 10 Hz to 10 MHz.

5–36. INPUT IMPEDANCE CHECK.

5–37. Input Capacity Check.

a. Connect a test oscillator to the input BNC of the 3055 Series Voltmeter thru a 100 KΩ resistor inserted directly into the BNC connector. See Figure 5–4. Connect the ground lead from the oscillator to the

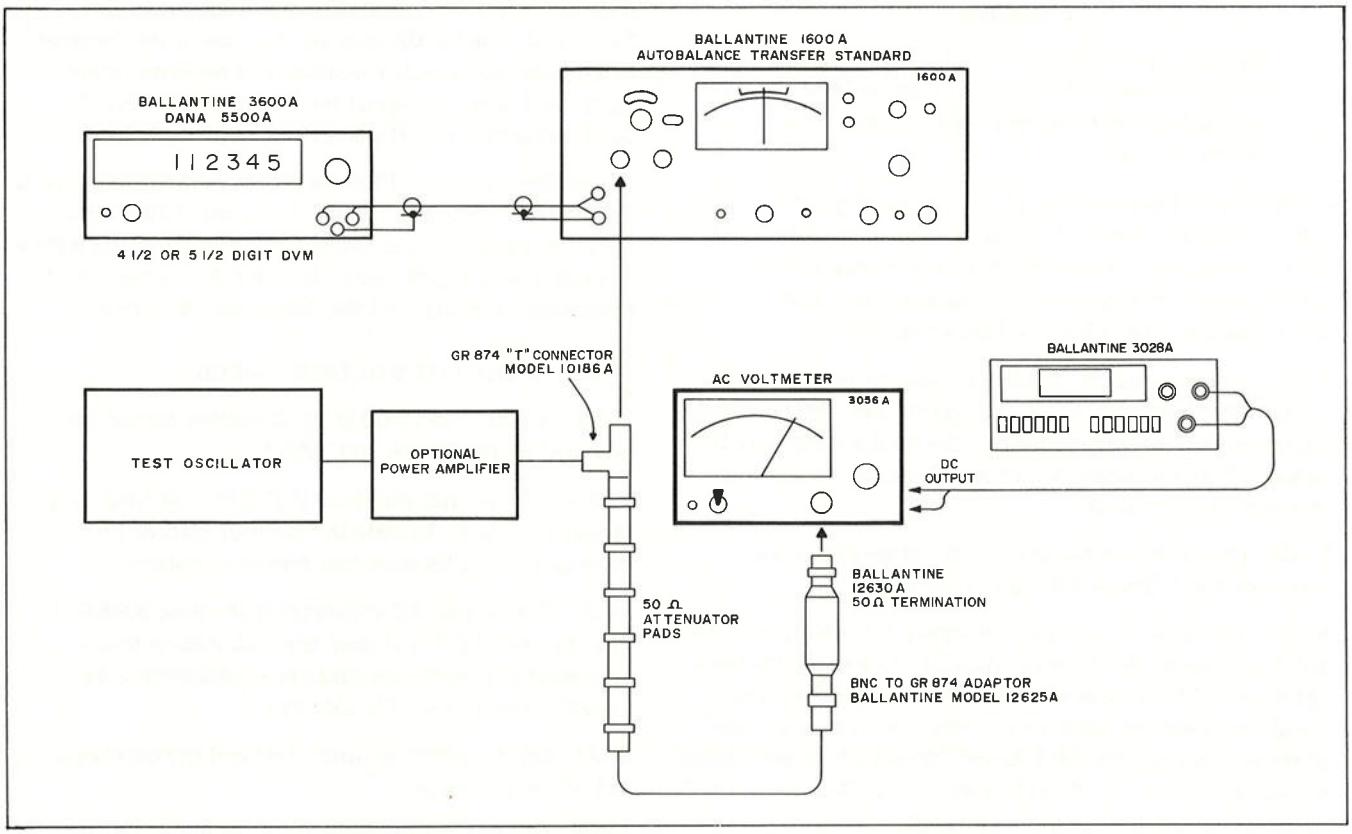


Figure 5–3. Autobalance Transfer Standard Test Setup

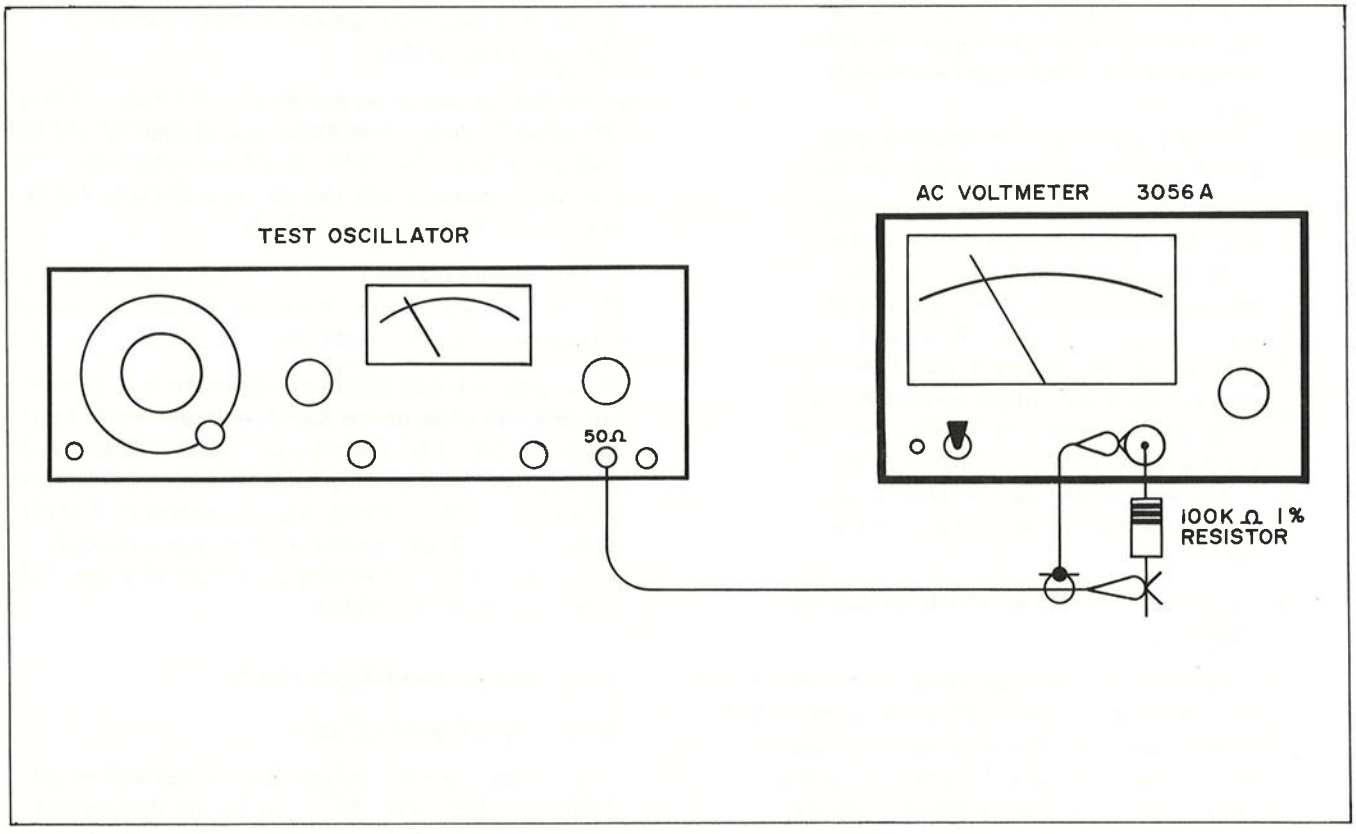


Figure 5–4. Input Impedance Test Setup

TABLE 5–4A. FREQUENCY RESPONSE TOLERANCE FOR 3055A

Frequency [Hz]	1 VOLT RANGE		
	Input [Volts]	Meter ±[% of Reading]	DC Output [Volts]
1 kHz	1.00	1.000 ± 1 % (REF)	1.00 ± 0.008
5 Hz	1.00	1.000 ± 10 %	1.00 ± 0.098
20 Hz	1.00	1.000 ± 2 %	1.00 ± 0.018
100 kHz	1.00	1.000 ± 1 %	1.00 ± 0.008
1.5 MHz	1.00	1.000 ± 1 %	1.00 ± 0.008
4 MHz	1.00	1.000 ± 3 %	1.00 ± 0.028
10 MHz	1.00	1.000 ± 5 %	1.00 ± 0.048
15 MHz	1.00	1.000 ± 10 %	1.00 ± 0.910
1 kHz	0.50	0.500 ± 2 % (REF)	0.50 ± 0.038
20 Hz	0.50	0.500 ± 4 %	0.50 ± 0.015
1.5 MHz	0.50	0.500 ± 2 %	0.50 ± 0.035
4 MHz	0.50	0.500 ± 4.5%	0.50 ± 0.035
10 MHz	0.50	0.500 ± 7.5%	0.50 ± 0.035
15 MHz	0.50	0.500 ± 15 %	0.50 ± 0.075
1 kHz	0.30	0.300 ± 3.3% (REF)	0.30 ± 0.003
20 Hz	0.30	0.300 ± 6.5%	0.30 ± 0.012
1.5 MHz	0.30	0.300 ± 3.3%	0.30 ± 0.030
4 MHz	0.30	0.300 ± 6.5%	0.30 ± 0.030
10 MHz	0.30	0.300 ± 10.8%	0.30 ± 0.030
15 MHz	0.30	0.300 ± 21.6%	0.30 ± 0.036

TABLE 5–4B. FREQUENCY RESPONSE TOLERANCE FOR 3056A

Frequency [Hz]	1 VOLT RANGE		
	Input [Volts]	Meter ±[% of Reading]	DC Output [Volts]
1 kHz	1.00	1.00 ± 1.0 % (REF)	1.00 ± 0.008
5 Hz	1.00	1.00 ± 10.0 %	1.00 ± 0.048
20 Hz	1.00	1.00 ± 2.0 %	1.00 ± 0.010
100 kHz	1.00	1.00 ± 1.0 %	1.00 ± 0.008
1.5 MHz	1.00	1.00 ± 1.0%	1.00 ± 0.008
4 MHz	1.00	1.00 ± 3.0 %	1.00 ± 0.028
10 MHz	1.00	1.00 ± 5.0 %	1.00 ± 0.048
15 MHz	1.00	1.00 ± 10.0 %	1.00 ± 0.098
1 kHz	0.50	0.50 ± 1.0 % (REF)	0.50 ± 0.038
20 Hz	0.50	0.50 ± 2.0%	0.50 ± 0.015
1.5 MHz	0.50	0.50 ± 1.0 %	0.50 ± 0.035
10 MHz	0.50	0.50 ± 5.0%	0.50 ± 0.035
15 MHz	0.50	0.50 ± 10.0 %	0.50 ± 0.075
1 kHz	0.30	0.30 ± 1.0 % (REF)	0.30 ± 0.003
20 Hz	0.30	0.30 ± 2.0 %	0.30 ± 0.012
1.5 MHz	0.30	0.30 ± 1.0 %	0.30 ± 0.030
4 MHz	0.30	0.30 ± 3.0 %	0.30 ± 0.030
10 MHz	0.30	0.30 ± 5.0 %	0.30 ± 0.030
15 MHz	0.30	0.30 ± 10.0 %	0.30 ± 0.036

TABLE 5–4C. FREQUENCY RESPONSE TOLERANCE

Frequency [Hz]	100 μV RANGE		
	Input [μ Volts]	Meter ±[% of Reading]	DC Output [Volts]
1 kHz	100	1 ± 2.0 % (REF)	1.00 ± 0.018
10 Hz	100	1 ± 10.0 %	1.00 ± 0.098
20 Hz	100	1 ± 4.0 %	1.00 ± 0.038
60 Hz	100	1 ± 2.0 %	1.00 ± 0.018
100 kHz	100	1 ± 2.0 %	1.00 ± 0.018
500 kHz	100	1 + 3.5%, – 5.0%	1.00 ± 0.048
4 MHz	100	1 + 3.5%, – 5.0%	1.00 ± 0.048
6 MHz	100	1 + 3.5%, – 5.0%	1.00 ± 0.048
1 kHz	50	0.5 ± 3.0% (REF)	0.50 ± 0.014
10 Hz	50	0.5 ± 15.0%	0.50 ± 0.078
20 Hz	50	0.5 ± 6.0%	0.50 ± 0.028
60 Hz	50	0.5 ± 3.0%	0.50 ± 0.015
100 kHz	50	0.5 ± 3.0%	0.50 ± 0.015
500 kHz	50	0.5 + 3.0%, –4.5%	0.50 ± 0.015
4 MHz	50	0.5 + 6.0%, –7.5%	0.50 ± 0.0375
6 MHz	50	0.5 + 6.0%, –7.5%	0.50 ± 0.0375

voltmeter BNC shell. Do not add any additional input capacity by using an input adapter or holding fixture for the resistor.

b. Set the 3055 Series Voltmeter to the 100 millivolt range and adjust the test oscillator to provide a 100 millivolt full scale reading on the voltmeter at 40 Hz.

c. Increase the frequency of the test oscillator until the voltmeter reads 70.7 millivolts. This should occur at a frequency of 66 kHz or higher to certify that the input capacity is 24 pF or less on the 300 millivolt range and all ranges to 1 millivolt.

d. Repeat steps b and c with the voltmeter set to 1 volt range. Set the oscillator amplitude to provide full scale meter indication at 40 Hz.

e. Increase the frequency of the test oscillator until the 3055A series meter decreases to 707 millivolts. This should occur at a frequency of 72 kHz or higher to certify that the voltmeter input capacity is 22 pF or less on the 1 Volt thru 1 kV ranges.

f. If Option 10 for constant input capacity is installed in the 3055 Series voltmeter note that the 1 Volt range test of steps d and e above should show 707 millivolts at 64 kHz or higher, and that the frequency reading of steps c and e are within ± 5 kHz. This certifies constant input capacity on all ranges from 100 μV thru 1 kV.

5–38. Input Resistance Check.

a. Connect the test oscillator to the input BNC of the 3055 Series voltmeter. Use the 50 ohm output of the oscillator.

b. Set the oscillator to 20 Hz and the voltmeter to the 1 Volt RANGE. Adjust the output amplitude of the test oscillator for a full scale meter indication on the voltmeter.

c. Connect a 100 KΩ resistor between the oscillator and the input BNC as shown in Figure 5–4.

d. The 3055 Series voltmeter indication should not decrease more than one percent. This certifies that the voltmeter input resistance is 10 megohms (100 KΩ is 1% of 10 MΩ) on the 1 Volt thru 1 kV ranges.

e. Repeat steps b, c and d on the 100 millivolt range to certify that the input resistance is 10 megohms on the 100 μV thru 100 millivolt ranges.

5–39. AC to DC CONVERTER OUTPUT IMPEDANCE CHECK.

5–40. Connect the 50 Ω output of the test oscillator to the input BNC of the 3055A series voltmeter. Use a 50 Ω termination at the input BNC.

5–41. Connect a dc digital voltmeter or multimeter to the dc output binding posts on the rear of the 3055A series voltmeter. Set the digital voltmeter to the 1000 millivolt range.

5–42. Set the 3055A series voltmeter to the 1 volt range. Set the oscillator frequency to 100 kHz and adjust the oscillator output amplitude to provide a reading of 1000 millivolts on the dc digital voltmeter.

5–43. Shunt a 499 ohm ± 1% film resistor across the DC OUTPUT of the 3055A series voltmeter. The voltage read on the digital meter should read between 450 and 550 millivolts to certify that the output impedance is 500 ohms ± 10%.

5–44. LINE VOLTAGE RANGE CHECK.

5–45. Connect line power to the 3055A series voltmeter thru a line voltage auto transformer (Variac). Measure the line voltage to the voltmeter with a true rms voltmeter. Set the line voltage to 115 (230) volts.

5–46. Connect a test oscillator to the input BNC of the 3055A series voltmeter and set both to the 1 Volt range.

5–47. Adjust the test oscillator output amplitude to provide a reading of 0.9 volts on the 3055A series voltmeter.

5–48. Slowly vary the frequency of the test oscillator from 45 to 1000 Hz and note that the voltmeter does not "swing" more than 1% as the oscillator frequency approaches the power line frequency or its harmonics. This checks ripple interference from the power supply.

5–49. Vary the power line voltage to the voltmeter from 115 (230) volts to 103 (206) volts and note that the voltmeter reading changes less than half percent.

5–50. Vary power line from 115 (230) volts to 127 (254) volts and note that the voltmeter readings change less than half percent.

5–51. CONCLUSION OF PERFORMANCE CHECKS.

5–52. When the 3055A series voltmeter has passed the above "covers on" Performance Assurance Checks, it has met its specifications as listed in Table 1–1. A calibration certification record may be maintained using Form 5–1.

5–53. CALIBRATION AND ALIGNMENT PROCEDURE.

5–54. The alignment and calibration procedures are "covers off" procedures to adjust the 3055A series of voltmeters to their performance specifications. If the voltmeter cannot be properly adjusted refer to the troubleshooting and fault finding procedures in paragraph 5–83.

5–55. REMOVAL OF COVERS.

5–56. The top and bottom covers of the 3055A series voltmeters are each retained by four half turn plastic fasteners. To remove the covers simply give each fastener a half turn to disengage the fastener pawl from under the end frame castings. Hold the cover firmly with both hands but do not press inward. Then simply lift the covers up and away from the instrument. To replace covers reverse the above procedure. Be sure that the covers slide into the retaining slot provided in the side extrusions and make certain all four fastener pawls engage the respective end castings. Turn the fasteners with care to avoid breakage.

Note

When making final calibration adjustments always have the bottom cover firmly installed since it serves as a shield to minimize noise pick up.

5–57. PRELIMINARY INSPECTION.

5–58. Always check the voltmeter for mechanical damage, loose parts, faulty solder joints, burned resistors, etc. Use a low wattage (25 watt) grounded soldering iron to make repairs and always replace components with exact equivalents to be certain that all performance specifications can be obtained. Use heat shunts when soldering diodes and semiconductors. Do not overheat circuit board printed wiring and pads.

5–59. INTERNAL ADJUSTMENTS AND TEST POINTS.

5–60. See Figure 5–5 for the location of internal adjustments and test points.

5–61. The adjustments for X1 Gain (A1R241), 100 μV Gain (A1R239), Meter X1 Linearity Adj. (A1R243), 100 μV Linearity Adj. (A1R257), and DC Out Gain Adj. (A1R247) are accessible from the rear panel in some instruments while others provide only access with covers off. The maintenance engineer may change to potentiometers which mount flat on the printed circuit board if only "covers off" access is desired. See attached parts list for identification of Ballantine parts for further details.

5–62. INITIAL POWER SUPPLY CHECK.

a. Connect the AC power line input to the voltmeter thru a line voltage control unit (Variac) and provide a true rms voltmeter to measure the input line voltage to the instrument under test.

b. Connect digital multimeter test leads to TP-L and the DC output circuit ground binding post J9 on the rear of the instrument. In voltmeters which do not incorporate a DC output, simply use any convenient case or circuit ground. Set the DMM to the 100 volt dc range.

c. Vary the input ac power line voltage from 98 to 130 volts (196 to 260 volts) and note that the +12 volt bus reads in the range of +11.3 to +12.7 volts with less than ±0.2 volts change due to line voltage variation.

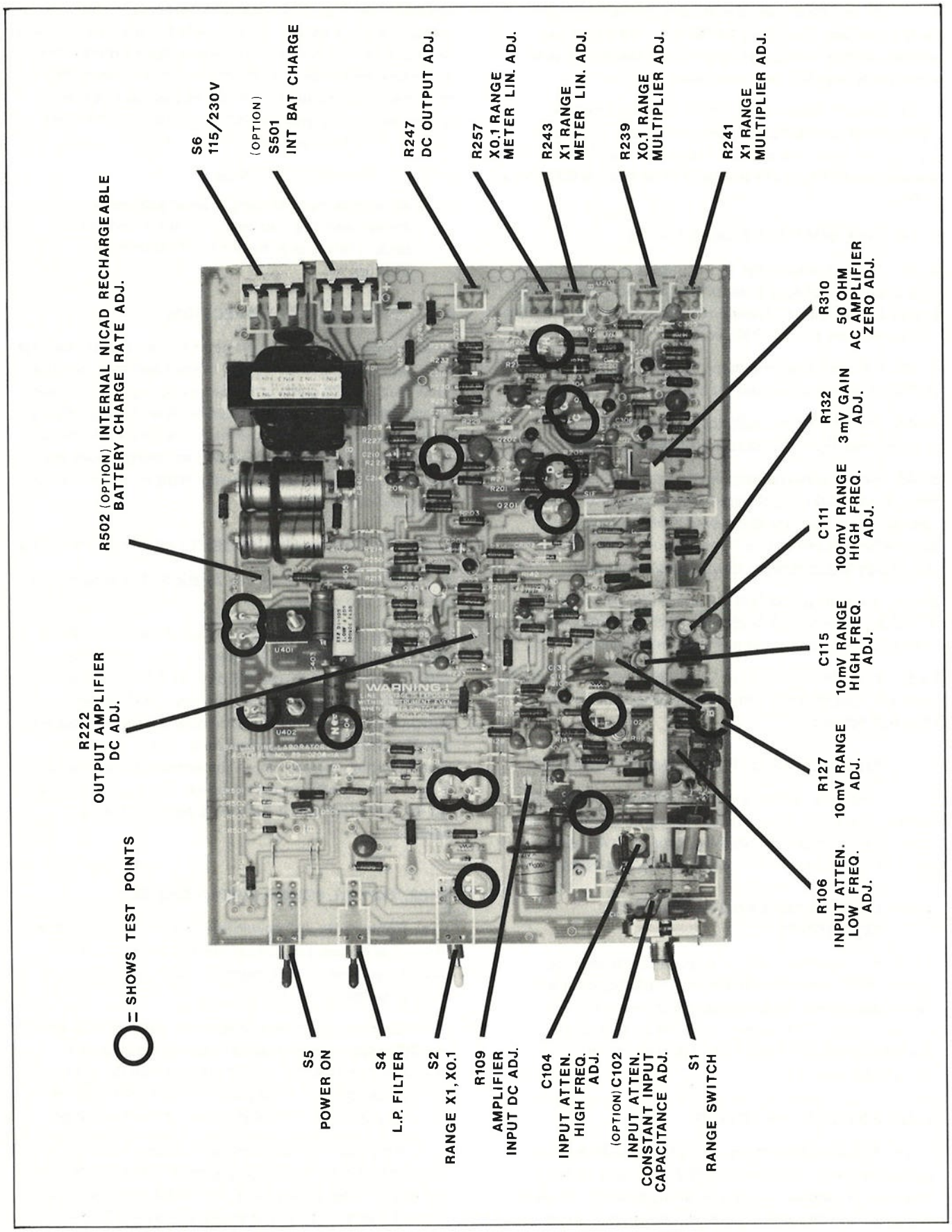

= SHOWS TEST POINTS
R222 OUTPUT AMPLIFIER DC ADJ.
R502 (OPTION) INTERNAL NICAD RECHARGEABLE BATTERY CHARGE RATE ADJ.
S6 115/230V
(OPTION) S501 INT BAT CHARGE
R247 DC OUTPUT ADJ.
R257 X0.1 RANGE METER LIN. ADJ.
R243 X1 RANGE METER LIN. ADJ.
R239 X0.1 RANGE MULTIPLIER ADJ.
R241 X1 RANGE MULTIPLIER ADJ.
R310 50 OHM AC AMPLIFIER ZERO ADJ.
R132 3mV GAIN ADJ.
C111 100mV RANGE HIGH FREQ. ADJ.
C115 10mV RANGE HIGH FREQ. ADJ.
R127 10mV RANGE ADJ.
R106 INPUT ATTEN. LOW FREQ. ADJ.
S5 POWER ON
S4 L.P. FILTER
S2 RANGE X1, X0.1
R109 AMPLIFIER INPUT DC ADJ.
C104 INPUT ATTEN. HIGH FREQ. ADJ.
(OPTION) C102 INPUT ATTEN. CONSTANT INPUT CAPACITANCE ADJ.
S1 RANGE SWITCH

Figure 5–5. Location of Adjustments and Test Points

d. Move the DMM test probe from TP-L to TP-N and repeat Step c. Check that the −12 Volt bus reads in the range of −11.3 to −12.7 Volts with less than ±0.2 volts change due to line voltage variation.

e. Return Variac to midline 115 V (230 V) and disconnect the DMM test leads.

5–63. INITIAL CONTROL SETTINGS. Applicable to all adjustments unless otherwise indicated.

a. Front Panel

RANGE	10 mV
FILTER	100 kHz
ON/OFF POWER	OFF
FLOAT	
REL REF (3056A only)	CAL
NORMAL/HOLD (3055A only)	NORMAL

b. Rear Panel

115/230 Volts	As required
BAT CHARGE (Option 05 3056A only)	NORM

5–64. BIAS ADJUSTMENTS.

5–65. Input Amplifier DC Adjustments (A1R109).

Note

Make checks with a battery powered DMM which permits floating off ground measurements. Connect the DMM LO input to the voltmeter circuit ground at J9 on the rear panel. ALWAYS use a 10 KΩ decoupling resistor at the DMM HI input test probe tip. This must be done when performing DC bias adjustments or whenever checking DC voltages in the voltmeter circuitry.

a. Connect a 50 Ω BNC termination (Ballantine 12630A) to input BNC to "short input".

b. Set DMM to the 1000 mV DC range.

c. Connect DMM leads from TP-B at A1Q101 to TP-E at A1Q105.

d. Adjust A1R109 to have DMM read "0" (±25 mV).

e. Disconnect DMM probes.

5–66. Output Amplifier DC Adjustments (A1R222).

a. Connect DMM probe to the emitter lead of A1Q206 at TP-F and other probe to circuit ground at J9 on the rear panel.

b. Adjust A1R222 to have DMM read zero mV (±10 mV).

c. Disconnect DMM probe from TP-F.

5–67. 50 Ω AC Output Zero Adj. (A1R310).

5–68. Connect DMM test lead to 50 Ω output BNC (J2) and circuit ground. Set DMM to 1000 mV dc Range. Adjust A1R310 to zero the 50 Ω output dc level (± 50 mV). Disconnect the DMM test leads and the 50 Ω termination at the input BNC (J1) connector.

5–69. CALIBRATION.

5–70. Preliminary Meter Linearity Adjustments (A1R243).

a. For 3055A be sure that zero and span front panel screw driver adjustments have been calibrated according to the instructions provided in the panel meter manual.

b. Connect AC calibrator to input BNC (J1) of voltmeter under test. See Figure 5–1.

c. Set 3055A series voltmeter to 100 mV range and apply 30 mV rms of 1 kHz from the calibrator.

d. Adjust A1R243 to have meter read 0.3 mV.

Note

All the following adjustments must be made in the sequence given below.

5–71. 10 mV Gain Adjustment (A1R132).

a. Connect the AC calibrator (Ballantine 421A) to the input BNC J1 of the 3055A series voltmeter. Connect a DC digital voltmeter to the DC output. See Figure 5–1.

b. Set calibrator to:
1 kHz rms
1 mV range
1.000 setting (for 1 mV output)

c. Set the 3055A series voltmeter RANGE to 1 mV.

d. Temporarily adjust A1R127 (the 1 mV gain adjust) and A1R241 (the X1 gain adjust) until the meter reads full range. Also adjust the DC output adjustment (A1R247) until the digital meter reads 1000 mV. Final settings of all three of these adjustments will be made later.

e. Switch voltmeter RANGE to 10 mV.

f. Increase calibrator output to 10 mV.

g. Adjust A1R132 for full range meter deflection (1.0) which should also provide 1000 mV on the digital DC meter. This adjustment normalizes the mid-range attenuator to the output impedance of the input amplifier.

5–72. 100 mV (X1) Range Calibration (A1R241 and A1R243.

a. Set 3055A series voltmeter RANGE switch to 100 mV.

b. Connect the AC amplitude calibrator to the voltmeter input BNC connector (J1). See Figure 5–1. Apply 90 mV of 1 kHz rms calibration signal to the voltmeter.

c. On the 3056A be sure the REL. REF. control is set to CAL.

d. Adjust A1R241 to give a meter reading of precisely 0.9 of full scale. If 0.9 meter indication cannot be obtained by adjusting A1R241, set A1R241 to approximately twenty degrees back from the end of potentiometer rotation which gives the closest meter reading to 0.9. Reduce calibration signal to 30 mV. Adjust X1 meter linearity adjust A1R243 for a meter reading of 0.3. Then repeat the 0.9 meter indication by again setting the calibrator to 90 mV and adjusting A1R241. If necessary repeat this procedure to optimize calibration and linearity.

5–73. DC Output Calibration (A1R247.)

a. Set voltmeter controls

LP FILTER	100 kHz
RANGE	100 mV
REL. REF. (3056A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 90 mV of 1 kHz rms signal. Be sure that the calibrator has minimal noise in its output signal.

c. Connect a digital multimeter to DC output binding posts J9 and J10. See Figure 5–1. Set DMM to 1000 mV DC range.

d. Adjust A1R247 to give a DMM reading of 900 mV (±3 mV).

e. Optional – Recheck 100 mV Meter Linearity control (A1R243). Reduce calibrator to 30 mV and check that the DMM reads 300 mV (±5 mV). If necessary repeat paragraph 5–72, Step "e" using the DMM as an indicator for adjustment.

5–74. 1 mV Range Calibration (A1R127).

a. Set 3055A series voltmeter controls

RANGE	1 mV
LP FILTER	100 kHz
REL. REF. (3056A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 900 μV 1 kHz rms.

c. Adjust A1R127 to have meter read precisely 0.9 full scale. Note that the DMM connected to the DC output binding posts reads 900 mV (± 2 mV).

5–75. 100 μV Range Calibration (A1R239 and A1R257).

a. Set 3055A series voltmeter controls

RANGE	100 μV
LP FILTER	100 kHz
REL. REF. (3056A only)	CAL.

b. Connect AC Voltage Calibrator to the input of the voltmeter and apply 90 μV of 1 kHz rms.

c. Adjust the A1R239 to give a meter reading of 0.9 of full range. Note that the DMM connected to the DC output binding posts reads 898 to 903 mV.

Calibrator	Cardinal Point	DMM Reading	Meter Reading
100.00	10	995 to 1005	9.9 to 10.1
90.00	9	898 to 903	8.95 to 9.05
80.00	8	795 to 805	7.9 to 8.1
70.00	7	695 to 705	6.9 to 7.1
60.00	6	595 to 605	5.9 to 6.1
50.00	5	495 to 505	4.9 to 5.1
40.00	4	395 to 405	3.9 to 4.1
30.00	3	192 to 207	2.9 to 3.1
20.00	2 (3055A only)	192 to 207	1.9 to 2.1
10.00	1 (3055A only)	0.90 to 110	0.8 to 1.2

d. Reduce calibrator voltage to 30 μV and adjust X0.1 meter linearity A1R257 for a meter reading of 0.3. Then repeat the 0.9 meter indication by again setting the calibrator to 90 μV and adjusting A1R239. If necessary repeat this procedure to optimize calibration and down scale linearity.

e. Optional – Check linearity and cardinal point alignment.

If necessary, repeat paragraph 5–75.

5–76. Input Attenuator Low Frequency Calibration (A1R106).

a. Set 3055A series voltmeter controls

RANGE	1 Volt
LP FILTER	100 kHz
REL. REF. (3056A only)	CAL.

b. Connect the AC voltage calibrator to the voltmeter input and apply 09 Volts 100 Hz rms.

c. Connect a digital multimeter to the DC output binding posts. Set the DMM to 1000 mV DC.

d. Adjust A1R106 to obtain a DMM reading of 900 mV (±2 mV) and note a meter reading of 0.9 of full range.

e. Optional – Attenuator Decading Checks.

AC Calibrator	Voltmeter Range	Touch Up Adj.	DMM	Meter
90.00 mV	100 mV	R241-METER R247-DMM	893 to 905	.89 to .91
.9000 mV	1 mV	R127	893 to 905	.89 to .91
9.000 mV	10 mV	R132	893 to 905	.89 to .91
.9000 mV	1 V	R106	893 to 905	.89 to .91
9.000 V	10 V	–	893 to 905	.89 to .91
900.0 V	1 kV	–	892 to 906	.89 to .91

5–77. 100 mV Range High Frequency Calibration (A1C111).

a. Set 3055A series voltmeter controls

RANGE	100 mV
L.P. FILTER	OUT
REL. REF. (3046A only)	CAL.

b. Connect a digital multimeter to the DC output binding posts. Set the DMM range to 1000 mV DC.

c. Connect constant amplitude signal generator (CASG) Tektronix 191 with 20 dB GR874 attenuator pads and 50 Ω feed thru termination to voltmeter input BNC (J1). Monitor CASG output with Ballantine 1394-1 thermal converter and monitor its thermo-element output with a 1 μV resolution DC digital voltmeter (or H-P 3420B Delta-Volter). See Figure 5–2 and Table 5–3.

d. Set CASG to 50 kHz and increase its output signal amplitude until the DMM reads 1000 mV. Note the output voltage from the thermo-element.

e. Increase the frequency of the CASG to 11 MHz and adjust the CASG output amplitude to maintain the thermo-element output voltage noted in Step "d".

f. Adjust A1C111 until the DC output voltage read on the DMM falls within the limits of the following tabulation. If necessary adjust A1C111 to fit all frequency response points.

Frequency	DC Output DMM Reading
50 kHz	1000 mV
1 MHz	990 to 1010
2.5 MHz	988 to 1012
5 MHz	950 to 1050
10 MHz	950 to 1050
15 MHz	910 to 1090

5–78. 10 mV Range High Frequency Calibration (A1C115).

a. Set 3055A series voltmeter controls

RANGE	10 mV
LP FILTER	OUT
REL. REF. (3056A only)	CAL.

b. Connect a digital multimeter to the DC output binding posts. Set the DMM range to 1000 mV DC.

c. Connect constant amplitude signal generator (CASG) Tektronix 191 with 40 dB GR874 attenuator pads and 50 Ω feed thru termination to voltmeter input BNC (J1). Monitor CASG output with Ballantine 1394-1 thermal converter and monitor its thermo-element output with a 1 μV resolution DC digital voltmeter (Ballantine 3620A or H-P 3420B Delta-Volter). See Figure 5–2 and Table 5–3.

d. Set CASG to 50 kHz and increase its output signal amplitude until the DMM reads 1000 mV. Note the output voltage from the thermo-element.

e. Increase the frequency of the CASG to 5 MHz and adjust the CASG output amplitude to maintain the thermo-element output voltage noted in Step "d".

f. Adjust A1C115 until the DC output provides a DMM reading of nominally 1005 mV (999 to 1012 mV).

g. Check the adjustment and fit of all points by repeating the procedure of paragraph 5–77f and adjust A1C115 if required.

5–79. Input Attenuator High Frequency Calibration (A1C104).

a. Set 3055A series voltmeter controls

RANGE	1 Volt
LP FILTER	OUT
REL. REF. (3056A only)	CAL.

b. Connect a digital multimeter (Ballantine 3028A) to the DC output binding posts J9 and J10. Set DMM to the 1000 mV DC range.

c. Connect the high frequency test set up of Figure 5–2. Use the 50 Ω output of the test oscillator (H-P 651) and use the thermal converter monitor as well as a 50 Ω feed thru termination at the input BNC of the 3055A series voltmeter.

d. Set the test oscillator frequency to 100 Hz and its output amplitude to give a reading of 1000 mV on the DMM.

e. Null the output voltage of the thermal converter on the H-P 3420B Delta-Volter or note the thermal converter output voltage if a DVM is used as monitor.

f. Increase the frequency of the test oscillator to 100 kHz and adjust its amplitude until the same thermal converter null or DVM reading noted in Step "e" is obtained. This assures constant signal input amplitude at 100 Hz and 100 kHz.

g. Adjust A1C104 until the DC output voltage of the voltmeter measured by the DMM is 1000 mV.

h. If components have been replaced check frequency response as in paragraph 5–77f. Select attenuator peaking resistor A1R146 for best high frequency response. Resistance range of A1R146 will fall between 4.7 Ω and 15 Ω.

5–80. CALIBRATION OF OPTIONS.

5–81. Option 10; Input Attenuator Constant Input Capacitance Adjust (A1C102).

Note

This adjustment is only required when constant input capacity Option 10 is installed. Be sure rear input Option 04 is disconnected at input BNC (J1) when adjustment of A1C102 is made.

a. Set 3055A series voltmeter controls

RANGE	100 mV
L.P. FILTER	OUT
REL. REF. (3056A only)	CAL.

b. Connect a 50 Ω precision 20 dB attenuator pad with 50 Ω feed thru-termination to a test oscillator. Connect the termination of the 3045A series voltmeter input BNC (J1) thru a 100 k Ω film resistor inserted directly into the BNC. See Figure 5–5. Connect the ground lead from the oscillator directly to the voltmeter BNC shell.

c. Connect a digital multimeter to the DC output binding posts J9 and J10. Set DMM to the 1000 mV DC range.

d. Set the test oscillator to 350 kHz and adjust its output amplitude until the DMM reads 1000 mV.

e. Set the 3055A series voltmeter to the 1 Volt RANGE and remove the 20 dB attenuator pad to increase the signal amplitude by a factor of ten.

f. Adjust A1C102 until the DMM reads 1000 mV (± 60 mV). A1C102 is a short length of 75 Ω twin lead cable. Its length determines the capacity shunted across the input on the 1 Volt thru 1 kV attenuator ranges to make them equal to the 100 μV thru 100 mV ranges. The capacity is adjusted by cutting the exposed end of the twin lead diagonally. DO NOT adjust A1C102 unless the DMM reading is out of the ± 60 mV tolerance band. If the reading is more than 1060 mV, replace the 75 Ω twin lead with a new and longer piece. If the DMM reading is less than 940 mV trim a small piece of the exposed end of the 75 Ω twin lead by cutting diagonally. Carefully dress the twin lead before making a final trim to bring the DMM reading within the range of 940 to 1060 mV.

5–82. Option 05; Internal NiCad Rechargeable Battery (3056A only); Option Charge Rate Adjust (A1R502).

Note

Be sure that the internal battery and charger components (Series 500) are installed and that A1R403 is not installed.

a. Be sure the battery is in serviceable condition with no open or shorted cells. If necessary, use a new battery to properly make this adjustment.

b. Open up the positive terminal lead to the battery. Use a soldering iron to unsolder the lead at the battery connector tab.

c. Insert a DMM with 100 mA DC ammeter capability (Ballantine 3028A) between the open battery connector tab and the lead disconnected in Step "b".

d. Connect the 3045A series voltmeter to the AC power line and set the BATTERY CHARGE slide switch accessible at the rear panel to FAST.

e. Adjust A1R502 until the DMM DC ammeter reads 60 (± 5) mA.

f. Switch BATTERY CHARGE switch to NORM and observe that the ammeter reads in the range of 4 to 12 mA.

g. Remove the AC power cord. Disconnect the DMM and reconnect the positive battery lead disconnected in Step "b".

Note

The battery should be recharged at the FAST rate for 10 to 16 hours. The battery voltage on a fully charged battery in good condition will be 28 to 33 Volts DC when powering the 3055A series voltmeter.

5–83. TROUBLESHOOTING AND FAULT FINDING.

5–84. The troubleshooting procedures should only be performed when the 3055A series voltmeter cannot be calibrated with the procedure of paragraph 5–66 through 5–82. Should the voltmeter be inoperative or completely out of specifications follow the fault finding procedures listed below. See paragraph 4–48 for removal of assembly A2 in the 3055A.

a. Carefully examine the instrument and check for any visual evidence of trouble. Check for broken wires, burned resistors, loose components, shorts or open or defective solder joints on the printed circuit board. Check for separation of printed circuit board lands and pads. Check for open, defective or intermittent switches. Check that instrument circuit ground is not shorted to chassis ground in those instruments which incorporate a FLOAT mode.

b. Understand and be familiar with the circuit theory of Section 4. Use the functional block diagram of Figure 4–1 and the schematic diagrams Figure 6–1 thru 6–6 to isolate the probable circuit areas which may cause the problem. Always check the power supply voltages and check for oscillations in the circuitry. Then refer to the fault finding and troubleshooting hints for that circuit detailed below. Table 5–10 gives some probable corrections for specific symptoms.

Note

Test voltages are given below and are also indicated on the schematic diagrams. All measurements are made with a high impedance battery operated floating digital multimeter (Ballantine 3028A). The DMM leads should be DC coupled with 10 k Ω resistors at the probe tips to avoid oscillations and input/output coupling in the amplifiers of the 3055A series voltmeter. All voltages are DC and referenced to circuit ground with tolerances ± 20% unless otherwise indicated. The voltmeter should have its input BNC (J1) shorted, RANGE set to 100 mV, and the FLOAT switch set to "⏚".

5–85. POWER SUPPLY.

5–86. Use a DC voltmeter (Ballantine 3028A DMM) to check the +12 and –12 volt supplies. Check the voltages listed on the power supply schematic Figure 6–3 and on Table 5–5. If the measured voltage is incorrect for a given test point or component, the fault is probably in that component or its surrounding circuitry. Use AC power input set to 115 (230) Volts.

TABLE 5–5. POWER SUPPLY VOLTAGES

Component	Test Point	DC Voltage
U401	K to N	+ 32 to + 40 V
U401	L to J9	+ 11.3 to + 12.7 V
U402	N to J9	– 11.3 to – 12.7 V
With MOD-05:		
B501	B + to B –	26 to 33 V
Q501 – Base	to N	1.8 V
Q501 – Emitter	to N	1.2 V

5–87. INPUT AMPLIFIER.

5–88. With input shorted and RANGE switch set to 100 mV check DC voltages with a sensitive DC voltmeter (Ballantine 3028A DMM). Use circuit ground as the reference and connect at binding post J9 on the rear panel. If voltages are not as indicated, trouble shoot the amplifier and correct the fault before proceding.

5–89. Set 3055A series voltmeter to 100 mV RANGE and apply a full range 1 kHz signal from AC voltage calibrator (Ballantine 421A). Use 3028 DMM on 1 Volt AC range to check AC signal at TP "I", the output of the input amplifier with maximum post attenuator attenuation. The rms voltage read by the DMM should be nominally 33 mV. If this voltage measures correctly the input amplifier operates correctly. If not check the components in the amplifier, leakage in the coupling capacitors, switch continuity and post attenuator operation.

TABLE 5–6. INPUT AMPLIFIER VOLTAGES

Transistor	Test Point	Base	Emitter	Collector
Q101	"A" + 2.7	–	–	–
Q101	"B" 0.55±0.25	–	–	–
Q102	–	+ 6.7	+ 7.3	+ 10.3
Q103	–	+ 7.3	+ 6.7	–0.3±0.3
Q104	–	+ 7.3	+ 6.7	+ 3.2
Q105	"E" 0.55±0.25	+0.55±0.25	–0.3±0.3	– 8.5

5–90. Switch RANGE to 10 mV and adjust the 1 kHz input for a full range meter reading. Repeat the measurements at TP "I" indicated in paragraph 5–89 to check the high gain operating mode of the input amplifier. Measure 33 mV AC or apply the corrective measures indicated above.

5–91. OUTPUT AMPLIFIER AND METER BRIDGE.

5–92. With input shorted and RANGE switch set to 100 mV check DC voltages with a sensitive DC voltmeter. Use circuit ground as reference. The DC checks are the best check for the amplifier since it is fully DC coupled and if voltages are incorrect the amplifier will not operate properly.

5–93. With 3055A series voltmeter range set to 100 mV apply a 1 kHz input signal from an AC voltage calibrator (Ballantine 421A). Adjust the input signal amplitude for full scale meter deflection. Check the DC voltage at TP "G" for a reading of ≈ -280 mV and TP "H" for a reading of ≈ + 280 mV. If these voltages are obtained the amplifiers and the average responding meter bridge are operating properly. If not check the circuit components, check capacitors for excess leakage and recheck the DC voltages outlined in Table 5–7.

TABLE 5–7. OUTPUT AMPLIFIER VOLTAGES

Transistor	Test Point	Emitter	Base	Collector
Q201	"I" 0	–0.6	0	–6.9±1.2
Q202	"C" 2.8±1.5	–0.6	0	2.8±1.5
Q203	–	–6.3±1.2	–6.9±1.2	–10.3±1
Q204	–	–7.0±1.2	–6.3±1.2	–0.6
Q205	–	–7.0±1.2	–6.3±1.2	11±1.6
Q206	"F" 0	0	–0.6	–10.5

5–94. METER AMPLIFIER.

5–95. The meter amplifier is a DC operational amplifier using negative feedback for gain stabilization. It is, therefore, only necessary to make DC voltage checks on U201. Set RANGE to 100 mV, FILTER to 100 kHz to reduce noise and make measurements with a high impedance DC voltmeter (Ballantine 3028 DMM).

If any of these voltages cannot be obtained check the components, switch S2B or replace U201. Note that the output of U201 with full range meter deflection is + 2V (± 0.2 V) measured at TP "J".

TABLE 5–8. METER AMPLIFIER VOLTAGES

	Pin 2	Pin 3	Pin 4	Pin 6	Pin 7
U201	0±0.2V	0±0.2V	–12V	+0.6±3V	+12V
CR801	0.6V±0.3V		across diode		
CR802	0.6V±0.3V		across diode		

5–96. AC OUTPUT AMPLIFIER.

5–97. To check the AC Output Amplifier for faults, first check the schematic diagram of Figure 6–2 or 6–5 applicable to the instrument under test. Then measure the DC voltages given in Table 5–9. Any incorrect voltage will indicate trouble in the associated stage.

TABLE 5–9. AC OUTPUT AMPLIFIER VOLTAGES

	EMITTER	BASE	COLLECTOR
Q301	–5.6	–6.2	–10.0±1
Q302	–1.7	–2.4	–6.2
Q302 (3015A only)	–2.3	–2.9	–5.1
Q303	–2.2	–2.8±1.5	–11.0

5–98. PRINTED WIRING BOARD REPAIR AND CLEANING.

5–99. The Ballantine 3055A series voltmeters use an etched copper printed circuit board. The main printed circuit board has conductors only on one side and does not use plated thru holes. To prevent damage to the circuit board and components observe the following instructions when soldering:

a. Use a low-heat capacity (Weller Model No. W-TCP 60 watt) soldering iron with a 700°F tip 1.5 mm (1/16") to 2.5 mm (3/32") wide.

b. Be sure that the soldering iron tip is grounded to the power line "earth" ground to avoid possible overvoltage damage to semiconductors and tantalytic capacitors. Also "earth" ground the case of the voltmeter.

c. To remove a component, clip a heat sink such as long nose pliers, tweezers or alligator clips onto the component lead and as close to the body of the component as possible. This assures minimum heating of the component while soldering.

Place the soldering iron directly on the component lead on the printed circuit conductor side of the board. Use a desoldering tool such as the SOLDAPULLT (manufactured by EDSYN Products) to remove all solder and free the component lead.

Straighten the bent over component lead with long nose pliers.

Pull the component out of the hole.

If a component is obviously faulty or damaged simply clip the leads close to the body of the component and remove the remaining leads thru the conductor side of the circuit board.

CAUTION

Always use a short soldering cycle since excessive or prolonged heat may destroy the laminate bond and life the copper conductors from the circuit board or cause immediate degradation or latent damage to the components.

d. Always clean the component lead holes by heating the solder on the circuit board conductor pad, then quickly remove the soldering iron and insert a pointed non-metallic object such as a toothpick to clean the hole. Never let solder cover the hole, since the incoming new component lead may then push the pad from the circuit board.

e. To install a new component, straighten and shape the leads. Insert the component into the proper holes. Bend the leads at the conductor side of the circuit board so they fall over the pad and extend over the foil of the incoming conductor path. Cut the bent lead approximately 2.5 mm (3/32") from the hole.

Clip a heat sink to the component lead at the body of the component. Heat the lead and pad with a soldering iron and use fresh solder (60-40) as required to cover the lead and form a meniscus over the hole to assure a good electrical connection.

f. Clean excess flux from the connection and surrounding area. Use TF Freon spray cleaner (such as Miller Stevenson Chemical Co., Type MS-180, Ballantine P/N 80-10004-0A) and use light air pressure (5 to 20 PSIG) and a clean soft brush to clean board and components. Use a humidity seal spray (such as Humiseal, Columbia Technical Corp., Type 1B15. Ballantine P/N 80-10005-0A) to seal board and protect against humidity AFTER cleaning.

Note

Do not touch cleaned board or excessively handle components to avoid unwanted leakage which may affect performance when exposed to high humidity.

TABLE 5–10. TROUBLESHOOTING AIDS

SYMPTOM	PROBABLE FAULT
1. Front Panel Pilot Lamp does not illuminate when power switch is ON.	1. AC power cord not properly inserted. Check power line fuse F1. If battery operated recheck battery. Check polarity of external battery connected to J7 and J6 (+). Check condition of U401 and U402. Check + 12V and – 12 V power supplies.
2. Meter reads up scale with no signal input.	2. Short input BNC connector J1. Set FLOAT switch to 1. Check for large external fields or improper power line voltages. Check adjustment of Meter Linearity and Zero Control A1R243. Turn instrument power OFF and check mechanical meter zero adjust. Check DC output reading and check or change meter if meter does not respond proportionally to DC output voltage. Check for oscillations by changing RANGE. Check high frequency calibration of A1C111 and A1C115.
3. No meter response to input signal.	3. Check input fuse A1F2 if one is installed in the instrument. Check power supply voltages. Check dc and ac signal operation detailed in Paragraphs 5–87 through 5–95.
4. High + 12 Volt and – 12 Volt Supply.	4. Check for incorrect setting of 115/230 Volt switch. Check A1U401 and A1U402 for shorted integrated circuit. Check A1U402 for open or non-regulating circuit. Replace regulators with units that are within rated voltage.
5. Low + 12 Volt and – 12 Volt.	5. Check setting of 115/230 Volt switch. Check line voltage input. Check for leaky or defective filter capacitors A1C401 and A1C402. Check operation of rectifier bridge. See that oscilloscope at test point shows ripple wave shape or replace rectifier and/or filter's capacitors. Replace regulators with units that are within rated voltage. Check that input current to A1U402 does not exceed 100 mA. Check possible defect in AC rectifiers and transformer by disconnecting AC power and using an external battery or DC power supply. In DC powered operation note that diodes A1CR505 and A1CR506 have a voltage drop less than 1 Volt.
6. Meter Oscillates or "swings".	6. Check power supply regulators if meter "swings" or beats when an input signal is applied which is close to the frequency of the power line or its harmonics.
7. Large Oscillations and instability in meter and AC Output	7. Check power supply. Short input. Recalibrate A1C111 and A1C115 according to Paragraphs 5–77 and 5–78. Check for leaky coupling capacitors and incorrect DC voltages in the amplifiers. Ground TP at input to output amplifier with short leads to eliminate loop oscillations. Remove instrument away from large AC radiated fields. Set FLOAT switch if Check that A1C222 is not open. If using rear input MOD-04 terminate with 50 Ω on front panel BNC and if necessary increase R107. See Paragraph 3–13.
8. High or low gain at high frequencies on all ranges.	8. Recalibrate A1C111 and A1C115 according to Paragraph 5–77 and 5–78.
9. High or low gain at high or low frequencies only on 1 Volt thru 300 Volt ranges.	9. Recalibrate the input attenuator compensating capacitor A1C104 according to Paragraph 5–79.
10. Meter responds improperly when AC input signal is superimposed on high DC level.	10. Replace input coupling capacitor A1C101.
11. Low gain at high frequencies on all ranges.	11. Check that L.P. FILTER switch is set to OUT. Recalibrate A1C111 and A1C115 according to Paragraphs 5–77 and 5–78.

TABLE 5–10. TROUBLESHOOTING AIDS (continued)

SYMPTOM	PROBABLE FAULT
12. Low gain at high frequencies only on 1 Volt thru 1 kV ranges.	12. Recalibrate the input attenuator compensating capacitor A1C104 according to Paragraph 5–79.
13. Low gain at low frequencies on all ranges.	13. Check A1C101, A1C134 and A1C123 and replace as necessary. Check condition of input FET A1Q101 and replace its leaky or low gain. Check A1C217 and A1C218.
14. Instrument will not range properly on 100 mV range and 100 Volt range.	14. Check that deck E of RANGE switch A1S1 is shorted in these ranges and that A1R121 is shorted by deck E.
15. Instrument will not range properly on 1 mV thru 10 mV and 1 V thru 10 V ranges.	15. Check that deck E of RANGE switch A1S1 is open only on these ranges and that A1R121 is effective.
16. Low readings near full scale on all ranges.	16. Check A1CR201 and A1CR202. Also check A1U201 and recalibrate X1 gain A1R241 and/or X0.1 gain A1R239.
17. Readings low on 100 mV and 100 Volt ranges near full scale.	17. Check input amplifier and A1Q105.
18. RANGE switch operation is erratic and/or some ranges will not operate.	18. Check switch wafers for continuity. Replace wafers that show noisy or intermittent operation. Check that detent is properly aligned. Check that all switch wafers are properly and squarely soldered into printed circuit board. Check that plastic switch shaft is not warped so that rearmost wafers DO NOT align properly and replace shaft if necessary.
19. Instrument will not range properly on 1 mV thru 100 mV ranges or 1 Volt thru 100 Volt ranges.	19. Check RANGE switch A1S1 decks A, B and C. Check A1R103 for improper low voltage ranging and A1C104, A1R105, A1R144/5/6 and A1C105/41/42 for improper high voltage ranging.
20. Oscillations when using 50 Ω or 600 Ω AC outputs.	20. Check lead dress of AC output leads to their respective BNC connectors. Check ground leads to these connectors and dress AC output leads away from DC output leads. Break ground loop thru power line ground by using 2 to 3 wire adapters on the power cable. Operate from external or internal battery to eliminate ground loop problems. See Section 3.
21. 1 mV range slightly out of calibration.	21. Fully recalibrate instrument and check A1C134. A1C123 as well as A1R133 and A1C131.
22. Excessive noise on 100 μV range.	22. Check power supply. Operate on batteries to check AC effects. Remove instrument and input cabling away from high radiated fields. Check for intermittent switches and connections. Replace input FET A1Q101.
23. AC OUTPUT Amplifier output signals low.	23. Check A1Q301, A1Q302, A1Q303, A1C303 and other associated components. Check that the series combination of A1C309 and A1R309 is shorted across A1R105 in the X0.1 mode.
24. 50 Ω AC OUTPUT distorted or not zero based.	24. Adjust A1R310 and check components in the surrounding amplifier circuitry.
25. Poor meter tracking or linearity on 100 μV Range.	25. Readjust A1R239 for full scale and A1R257 for 0.3 tracking. Follow the calibration procedure of Paragraph 5–72.
26. Poor meter tracking or linearity on 1 mV to 1 kV Ranges.	26. Readjust A1R241 for full scale and A1R243 for 0.3 down scale tracking.

PERFORMANCE TEST RECORD

Ballantine Model _____ **OPTION** _____ **Serial No.** _____
Test Performed By: _____ **Date:** _____

1. POWER SUPPLY CHECK

	Specification	Indication
Low line	<103 (206 V) rms	
High line	>127 (254 V) rms	

2. ACCURACY CHECK – Full Scale

	Input		Specification		Indication	
RANGE	Volts	Frequency	Meter (% of Reading)	DC Output (m Volts)	Meter (% of Reading)	DC Output (Volts)
100 μV	100 μV	1kHz	1±1%	99 to 1008		
1mV	1 mV	1kHz	1±1%	99 to 1008		
10mV	10mV	1kHz	1±1%	99 to 1008		
100mV	100mV	1kHz	1±1%	99 to 1008		
1V	1.00V	1kHz	1±1%	99 to 1008		
10V	10.0V	1kHz	1±1%	99 to 1008		
100V	100V	1kHz	1±1%	99 to 1008		
1kV	1000 V	1 kHz or 400 Hz	1±1%	99 to 1008		

3. FREQUENCY RESPONSE TOLERANCE

For Specifications Use Table 5–4 as applicable.

If desired use the 1 Volt RANGE tolerances for making optional checks of the 1mV, 10mV, 100mV, 10V, 100V and 1kV RANGES.

	Input		Specification		Indication	
RANGE	Volts	Frequency	Meter (% of Reading)	DC Output (Volts)	Meter (% of Reading)	DC Output (Volts)
1V	1.00	1kHz	±%	1.00±0.		
	1.00		±%	1.00±0.		
	1.00		±%	1.00±0.		
	1.00		±%	1.00±0.		
	1.00		±%	1.00±0.		
	1.00		±%	1.00±0.		
	1.00		±%	1.00±0.		
	0.05	1kHz	±%	0.50±0.		
	0.50		±%	0.50±0.		
	0.50		±%	0.50±0.		
	0.50		±%	0.50±0.		
	0.50		±%	0.50±0.		
	0.50		±%	0.50±0.		
	0.50		±%	0.50±0.		

4. INPUT IMPEDANCE

	Specification	Indication
RESISTANCE CHECK	10 MΩ/<1 minor div.	
CAPACITANCE CHECK		
1mV to 100mV RANGE	< 24pF > 66kHz	kHz
1V to 1kV RANGE	< 22pF > 72kHz	kHz
with constant Input Capacity	20 to 24pF > 66kHz	kHz

5. AC AMPLIFIER OUTPUT

	Specification	Indication
Full Scale Output	Min mV rms	
50 Ω		
1kHz	≤150	mV
10Hz to 1kHz	<135	mV
1kHz to 4MHz	<147	mV
4MHz to 10MHz	<141	mV
600 Ω		
1kHz	≥1000	mV
10Hz to 1kHz	>900	mV
1kHz to 4MHz	>950	mV
4MHz to 10MHz	>800	mV

6. AC TO DC CONVERTER OUTPUT RESISTANCE

	Specification	Indication
Output Resistance	450 Ω to 550 Ω	Ω

SECTION 6
PARTS LIST & CIRCUIT DIAGRAMS

The replacement parts listed are available from the vendors listed or from Ballantine Laboratories. Your local Ballantine Field Engineering Representative may also carry a stock of parts and can assist you. If pricing quotations are required for parts and or repairs your local representative will give the most rapid service or you may contact the Ballantine Factory directly.

When ordering replacement parts always give the following information:

a) Instrument Model number
b) Serial number
c) Ballantine Part number
d) Schematic Symbol number
e) Identification and description of the part

Ballantine will do its best to improve the instrument and make changes in style of components and replacement parts. Replacement parts may differ in appearance from those found in your instrument but are always equal or superior in performance. Where necessary minor mechanical modifications may be required in the replacement of the components.

Parts are generally available locally for most replacements. The parts list calls out the recommended vendors where applicable.

The instrument may substitute alternate components but the use of parts specified in this parts list is recommended. A part similar to the part initially installed at the factory may be used, i.e., a 5% composition resistor may be replaced with a similar part or a 5% film resistor or the preferred 1% metal film resistor. Use of the preferred component will always simplify calibration and speed repairs.

Any selected component is generally identified in this manual and may be replaced with a similarly valued part unless reselection is required due to replacement or change of its related part. The schematics and calibration procedures identify selected components and replacement procedures.

The Manufacturer Code is taken from Federal Supply Code Cataloging Handbooks H4-1, H4-2, and H4-3. Ballantine Code is 50423.

The following parts coding are used:

CVC	Capacitor, Variable, Ceramic
CCT	Capacitor, Ceramic, Tubular
CFP	Capacitor, Fixed, Plastic
CCD	Capacitor, Ceramic, Disc
CYF	Capacitor, Mylar, Foil
CMD	Capacitor, Mica, Dipped
CMM	Capacitor, Mica, Molded
CEA	Capacitor, Electrolytic, Aluminum
CET	Capacitor, Electrolytic, Tantalum
DGP	Diode, General Purpose
DZG	Diode, Zener, General Purpose
DRP	Diode, Bridge, Power
FLT	Filter
ICP	Integrated Circuit
TRQ	Transistor
RFF	Resistor, Fixed, Film
RFC	Resistor, Fixed, Composition
RVC	Resistor, Variable, Composition
RFW	Resistor, Fixed, Wirewound
SWC	Switch
LMP	Lamp
TRX	Transformer

Resistors may generally be replaced by Corning Electronics (CCW) type N-55, N-60 and C-32. Allen Bradley carbon composition resistors type EB may also be used but should generally be avoided (except for emergency replacements) in favor of the preferred part listed in this parts list.

MAIN P.C. BOARD (3056A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
---	89102801A	MAIN PC BOARD ASSY	50423	
C 101	07102510A	CYM 22.0NF 1.6KVK MET POL	80031	MEPCO C281/1600/A22K
C 102	79054730A	CBL FXR	29587	AMPHENOL #214-079
C 103	07025430A	CCD 1.5NF 3 KV M -20+80%	72982	ERIE 878 H1-K DISC Y5V
C 103	07095740A	CCD 1.5NF 1.0KV +-10%	71590	CTL TYP DD-152
C 104	07101780A	CVP 10.0PF 750.0 VT 2-10PF	50423	
C 105	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 106	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 107	07101790A	CET. 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 108	07078330A	CEA1000 UF 16 V T	73445	AMPEREX C437AR/E1000
C 109	07100060A	CCD 4.7PF 500 V DISC	90201	RMC TYPE CG
C 110	07100810A	CCD 3.3PF 500. V	90201	RMC TYPE CG
C 111	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	
C 112	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C0008102F180J
C 113	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 114	07101530A	CCD 6.8PF 500.0 V NPO+-1PF	72982	ERIE 801 NPO 6.8PF 1P500V
C 115	07101810A	CVP 10.0PF 750.0 V 2-10PF	50423	
C 116	07095800A	CDD 100 PF J 5%	56289	SPG TYP 10TCC-T10
C 117	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C0008102F180J
C 118	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 119	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 120	07102360A	CCD 3. NF 1. KVK	56289	SPRAGUE C016B102K302K
C 121	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 122	07102430A	CCD 6.8NF 250.0 VK	56289	SPRAGUE C067A251J682K
C 123	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 125	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C0008102F180J
C 126	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 127	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 128	07022220A	CMM 10 PF 500 V J 5%	84171	ARCO TYPE CM15-E-010J
C 130	07102140A	CCD 47. NF 25. VM	56289	SPR C069B250J473M OR EQUV
C 132	07101050A	CMD 150.0PF 500 V +-5,	84171	ELMENCO DM1515J
C 133	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 134	07102380A	CTF 150.0UF 15.0VK	56289	SPRAGUE 196D157X9015MA3
C 141	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 142	07102150A	CMM 1.1NF 500. VJ SILV M1	84171	ARCO CM20E112J OR EQUIV.
C 202	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 203	07102370A	CTF 100. MF 20. VK	56289	SPRAGUE 196D107X9020MA3
C 205	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 206	07101530A	CCD 6.8PF 500.0 V NPO+-1PF	72982	ERIE 801 NPO 6.8PF 1P500V
C 207	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 208	07101800A	CCD 18.0PF 1.0KVJ NPO	56289	SPRAGUE C0008102F180J
C 209	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 210	07101850A	CCD 6.2PF 500.0 VJ NPO	91418	RMC CG 6+2 PF
C 211	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 214	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 215	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 216	07101860A	CCD 8.2PF 500.0 VJ NPO	91418	RMC CG 8+2 PF
C 217	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 218	07101840A	CET 100.0UF 10.0 VM DIP TAN	56289	SPRAGUE 196D107X0010-LA3
C 220	07101870A	CET 3.3UF 10.0 VM DIP TAN	56289	SPRAGUE 1960335X0015
C 221	07102490A	CYM 1.0UF 100.0 VK MET MYL	80031	MEPCO C280AH/A1M
C 222	07102000A	CYM 220.0NF 100.0 VK MET MYL	14752	ELEC-CUB 230D18224K OR EQ
C 223	07095740A	CCD 1.5NF 1.0KV +-10%	71590	CTL TYP DD-152
C 301	07101290A	CTF 47. UF 35. V	50423	
C 303	07101790A	CET 22.0UF 15.0 VM	56289	SPRAGUE 196D226X0015KE3
C 305	07101830A	CET 47.0UF 20.0 VM DIP TAN	56289	SPRAGUE 196D476X0020-LA3
C 309	07102440A	CET 330.0UF 6.0 VK	56289	SPRAGUE 196D337X9006 MA3
C 310	07101970A	CCD 33.0PF 1.0KVJ NPO	56289	SPRAGUE C030B102G330J EQV

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
C 401	07078250A	CEA 220.0UFD 63.0V T -10+50%	73445	AMPEREX ET221X063A02
C 402	07078250A	CEA 220.0UFD 63.0V T -10+50%	73445	AMPEREX ET221X063A02
C 403	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 404	07102350A	CEA 100. MF 25. VT	73445	AMPREX ET101X025A5
C 405	07101280A	CYM 1.0UF 50.0 VK	56289	SPRAGUE 431P1059R5 OR EQV
CR 101	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 102	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 201	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 202	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 203	05100210A	DGP 5082-2835 LOW OFF-SET	28480	HP SCHOTTKY.34 FWD 5VRVS
CR 401	05100530A	DGP 920A-6	04713	MOT
CR 505	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
CR 506	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
CR 801	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 802	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
ICP 201	24094290A	ICP 8 LD MET CAN FCHD MA741C	07263	FCHLD U5B7741312
ICP 401	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FAIRCHILD 78M12C OR EQUIV
ICP 402	24100510A	ICP 12 VOLT REG 78M12C 1/2A	07263	FAIRCHILD 78M12C OR EQUIV
Q 101	10100781A	TRQ 40673 SEL FOR IDS	50423	
Q 102	10080550A	TRQ 2N 918 PNP 1 15 PT0-18	07263	FCH .300 900M 20
Q 103	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 104	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 105	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 201	10101221A	TRQ MPSH81 SEL BETA	50423	
Q 202	10101221A	TRQ MPSH81 SEL BETA	50423	
Q 203	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 204	10080550A	TRQ 2N 918 PNP 1 15 PT0-18	07263	FCH .300 900M 20
Q 205	10080550A	TRQ 2N 918 PNP 1 15 PT0-18	07263	FCH .300 900M 20
Q 206	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 301	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 302	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 303	10101210A	TRQ MPSH81 PNP 1 20 ST0-92	04713	MOT. MPSA81350 1 2G 60
Q 501	10100040A	TRQ MJE520 NPN 1 30 P77-03	04713	MOT 25 25
R 101	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW RN60D 10R0 F
R 102	12088650A	RFF 10.0 M 500.0MW F+- 1%	03888	PYF TYP PME-70
R 103	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW RN60D 1003 F
R 104	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW RN60D 2870 F
R 105	12124160A	RFF 14.7 K 500 MW F+-1%	16299	CGW RN60D 1472 F
R 106	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 107	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW RN60D 3161 F
R 108	12123440A	RFF 2.87K 500 MW F+-1%	16299	CGW RN60D 2871 F
R 109	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 110	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 111	12122880A	RFF 825.0 500 MW F+-1%	16299	CGW RN60D 8250 F
R 112	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 113	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 114	12122280A	RFF 196.0 500 MW F+-1%	16299	CGW RN60D 1960 F
R 115	12122840A	RFF 750.0 500 MW F+-1%	16299	CGW RN60D 7500 F
R 116	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW RN60D 3161 F
R 117	12122600A	RFF 422.0 500 MW F+-1%	16299	CGW RN60D 4220 F
R 118	12123160A	RFF 1.47K 500 MW F+-1%	16299	CGW RN60D 1471 F
R 119	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW RN60D 3831 F
R 120	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 121	12122280A	RFF 196.0 500 MW F+-1%	16299	CGW RN60D 1960 F
R 122	12123160A	RFF 1.47K 500 MW F+-1%	16299	CGW RN60D 1471 F
R 123	12123040A	RFF 1.10K 500 MW F+-1%	16299	CGW RN60D 1101 F
R 124	12121840A	RFF 75.0 500 MW F+-1%	16299	CGW RN60D 75R0 F
R 126	12123720A	RFF 5.62K 500 MW F+-1%	16299	CGW RN60D 5621 F

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 127	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 128	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 129	12122480A	RFF 316.0 500 MW F+-1%	16299	CGW RN60D 3160 F
R 130	12123680A	RFF 5.11K 500 MW F+-1%	16299	CGW RN60D 5111 F
R 131	12123800A	RFF 6.81K 500 MW F+-1%	16299	CGW RN60D 6811 F
R 132	09100010A	RVC 500.0 0.5 W K	73138	HEL TYP 72PM
R 133	12122400A	RFF 261.0 500 MW F+-1%	16299	CGW RN60D 2610 F
R 134	12122680A	RFF 511.0 500 MW F+-1%	16299	CGW RN60D 5110 F
R 135	12127720A	RFF 563.6 250.0MW A	03888	PYROFILM PME60T9 563.6
R 136	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 137	12127710A	RFF 481.2 250.0MW A	03888	PYROFILM PME60T9 481.2
R 138	12127700A	RFF 711.6 250.0MW A	03888	PYROFILM PME60T9 711.0
R 139	12127690A	RFF 329.0 250.0MW A	03888	PYROFILM PME60T9 329.0
R 140	12121680A	RFF 51.1 500 MW F+-1%	16299	CGW RN60D 52R3 F
R 141	12122280A	RFF 196.0 500 MW F+-1%	16299	CGW RN60D 1960 F
R 142	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 143	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 144	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW RN60D 10R0 F
R 145	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW RN60D 10R0 F
R 146	12128150A	RFC 6.8 125.0MW J+- 5%	01121	A-B TYPE BB
R 147	12123920A	RFF 9.09K 500 MW F+-1%	16299	CGW RN60D 9091 F
R 148	12123280A	RFF 1.96K 500 MW F+-1%	16299	CGW RN60D 1961 F
R 149	12122000A	RFF 100.0 500 MW F+-1%	16299	CGW RN60D 1000 F
R 150	12123000A	RFF 1.0 K 500 MW F+-1%	16299	CGW RN60D 1001 F
R 151	12123880A	RFF 8.25K 500 MW F+-1%	16299	CGW RN60D 8251 F
R 152	12128180A	RFF 13.7 K 125.0MW A	03889	PYR PME-60 13.678KT-9.1%
R 153	12128190A	RFF6322.0 125.0MW A	03889	PYR PME-60 6.322KT-9.1%
R 201	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW RN60D 3831 F
R 203	12123320A	RFF 2.15K 500 MW F+-1%	16299	CGW RN60D 2151 F
R 204	12121320A	RFF 21.5 500 MW F+-1%	16299	CGW RN60D 21R5 F
R 205	12121320A	RFF 21.5 500 MW F+-1%	16299	CGW RN60D 21R5 F
R 206	12123400A	RFF 2.61K 500 MW F+-1%	16299	CGW RN60D 2611 F
R 207	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 208	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW RN60D 3161 F
R 209	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 210	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 211	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW RN60D 3831 F
R 212	12124280A	RFF 19.6 K 500 MW F+-1%	16299	CGW RN60D 1962 F
R 213	12123440A	RFF 2.87K 500 MW F+-1%	16299	CGW RN60D 2871 F
R 214	12122840A	RFF 750.0 500 MW F+-1%	16299	CGW RN60D 7500 F
R 215	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 216	12123560A	RFF 3.83K 500 MW F+-1%	16299	CGW RN60D 3831 F
R 217	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 218	12122880A	RFF 825.0 500 MW F+-1%	16299	CGW RN60D 8250 F
R 219	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 220	12122560A	RFF 383.0 500 MW F+-1%	16299	CGW RN60D 3830 F
R 221	12123760A	RFF 6.19K 500 MW F+-1%	16299	CGW RN60D 6191 F
R 222	09100020A	RVC 5.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 223	12123680A	RFF 5.11K 500 MW F+-1%	16299	CGW RN60D 5111 F
R 224	12122560A	RFF 383.0 500 MW F+-1%	16299	CGW RN60D 3830 F
R 225	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 226	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW RN60D 3161 F
R 227	12122480A	RFF 316.0 500 MW F+-1%	16299	CGW RN60D 3160 F
R 228	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 230	12124400A	RFF 26.1 K 500 MW F+-1%	16299	CGW RN60D 2612 F
R 231	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW RN60D 2870 F
R 232	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW RN60D 2870 F

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
R 233	12124400A	RFF 26.1 K 500 MW F+-1%	16299	CGW RN60D 2612 F
R 234	12123180A	RFF 1.54K 500 MW F+-1%	16299	CGW RN60D 1541 F
R 235	12123080A	RFF 1.21K 500 MW F+-1%	16299	CGW RN60D 1211 F
R 236	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW RN60D 1002 F
R 237	12123880A	RFF 8.25K 500 MW F+-1%	16299	CGW RN60D 8251 F
R 238	12125560A	RFF 383.0 K 500 MW F+-1%	16299	CGW RN60D 3833 F
R 239	09101200A	RVF 100.0 K 250.0MW K CERMET	73138	HELIPOT 72XW VERT MT
R 240	12124480A	RFF 31.6 K 500 MW F+-1%	16299	CGW RN60D 3162 F
R 241	09100930A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 243	09100930A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 246	12122840A	RFF 750.0 500 MW F+-1%	16299	CGW RN60D 7500 F
R 247	09100940A	RVF 500.0 500.0MW KVERT MT	73138	HELIPOT 72XW 500
R 248	12122840A	RFF 750.0 500 MW F+-1%	16299	CGW RN60D 7500 F
R 249	12125680A	RFF 511.0 K 500 MW F+-1%	16299	CGW RN60D 5113 F
R 250	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 251	12123480A	RFF 3.16K 500 MW F+-1%	16299	CGW RN60D 3161 F
R 252	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 253	12010020A	RFC 6.8 M 500.0MW K+-10%	01121	A-B TYP EB
R 254	12125480A	RFF 316.0 K 500 MW F+-1%	16299	CGW RN60D 3163 F
R 255	12124000A	RFF 10.0 K 500 MW F+-1%	16299	CGW RN60D 1002 F
R 256	12123680A	RFF 5.11K 500 MW F+-1%	16299	CGW RN60D 5111 F
R 257	09100930A	RVF 10.0 K 500.0MW KVERT MT	73138	HELIPOT 72XW 10K
R 258	12125280A	RFF 196.0 K 500 MW F+-1%	16299	CGW RN60D 1963 F
R 259	12121080A	RFF 12.1 500 MW F+-1%	16299	CGW RN60D 12R1 F
R 301	12123080A	RFF 1.21K 500 MW F+-1%	16299	CGW RN60D 1211 F
R 302	12121680A	RFF 51.1 500 MW F+-1%	16299	CGW RN60D 52R3 F
R 303	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW RN60D 5620 F
R 304	12122160A	RFF 147.0 500 MW F+-1%	16299	CGW RN60D 1470 F
R 305	12122520A	RFF 348.0 500 MW F+-1%	16299	CGW RN60D 3480 F
R 306	12122600A	RFF 422.0 500 MW F+-1%	16299	CGW RN60D 4220 F
R 307	12122760A	RFF 619.0 500 MW F+-1%	16299	CGW RN60D 6190 F
R 309	12121440A	RFF 28.7 500 MW F+-1%	16299	CGW RN60D 28R7 F
R 310	09100080A	RVC 10.0 K 0.5 WK +-10%	73138	HEL TYP 72PM
R 311	12124280A	RFF 19.6 K 500 MW F+-1%	16299	CGW RN60D 1962 F
R 312	12123000A	RFF 1.0 K 500 MW F+-1%	16299	CGW RN60D 1001 F
R 313	12122160A	RFF 147.0 500 MW F+-1%	16299	CGW RN60D 1470 F
R 314	12121560A	RFF 38.3 500 MW F+-1%	16299	CGW RN60D 38R3 F
R 315	12122720A	RFF 562.0 500 MW F+-1%	16299	CGW RN60D 5620 F
R 320	12123940A	RFF 9.53K 500 MW F+-1%	16299	CGW RN60D 9531 F
R 321	12121880A	RFF 82.5 500 MW F+-1%	16299	CGW RN60D 82R5 F
R 401	12121210A	RFF 16.5 500 MW F+-1%	16299	CGW RN60D 16R5 F
R 402	12122680A	RFF 511.0 500 MW F+-1%	16299	CGW RN60D 5110 F
R 403	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW RN60D 1003 F
R 601	09101041A	RVC 10.0 K 250.0MW MTAPER A	11263	CTS NS200 1/4BU .5PL SHFT
R 602	12122800A	RFF 681.0 500 MW F+-1%	16299	CGW RN60D 6810 F
R 801	12123720A	RFF 5.62K 500 MW F+-1%	16299	CGW RN60D 5621 F
R 802	12123200A	RFF 1.62K 500 MW F+-1%	16299	CGW RN60D 1621 F
R 803	12122440A	RFF 287.0 500 MW F+-1%	16299	CGW RN60D 2870 F
R 804	12123760A	RFF 6.19K 500 MW F+-1%	16299	CGW RN60D 6191 F
S 4	25100760A	SWC TOG SPDT PC VERT NON THD	09353	C+K 7101 SY AV2 NON THD
S 5	25100750A	SWC TOG DPDT PC VERT NON THD	09353	C+K 7201 SY AV2 NON THD
S 6	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040
S 1A	25100811B	SWC SECT 1 OF 25100801B	50423	
S 1B	25100821B	SWC SECT 2 OF 25100801B	50423	
S 1C	25100831B	SWC SECT 3 OF 25100801B	50423	
S 1D	25100841A	SWC SECT 4 OF 25100801B	50423	
S 1E	25100851A	SWC SECT 5 OF 25100801A	50423	

MAIN P.C. BOARD (3056A) -- Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
S 1F	25100861A	SWC SECT 6 OF 25100801A		
S 1G	25100871D	SWC SECT 7 OF 25100801A		
S 1H	25100881B	SWC SECT 8 OF 25100801A		
T 401	20100210A	TRX POWER (3045A)	08779	SIGNAL TRANS CPC-56-180
Z 401	14100000A	REG LINE SURGE SUPPRESSOR	24446	GE VP 150A10
		OPTION 05 ALSO INCLUDES:		
CR 501	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 503	05079200A	DGP 1N4148 75 10M	07263	FCH SI D035
CR 504	05080580A	DGP 1N4006 400 1A	15238	ITT SI D046
Q 501	10100040A	TRQ MJE520 NPN 1 30 P77-03	04713	MOT 25 25
R 403	12125000A	RFF 100.0 K 500 MW F+-1%	16299	CGW RN60D 1003 F
R 501	12124440A	RFF 28.7 K 500 MW F+-1%	16299	CGW RN 60D 2872 F
R 502	09100950A	RVF 50.0 500.0MW M	73138	HELIPOT 72PM 50
R 503	12122240A	RFF 178.0 500 MW F+-1%	16299	CGW RN60D 1780 F
S 501	25100620A	SWC SLIDE PC RT ANGLE DPDT	78488	STACKPOLE SS-50-5PN785040

FRONT PANEL (3056A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
---	89102811A	FRONT PANEL ASSY	50423	
DS 1	16100000A	LMP PAN GALIUM ARSENIDE	28480	(HP)-5082-4440
J 1	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
M 201	18100121G	MTR 3055A 1MA FS 1%ACC.5% TR	32171	MODUTEC LOG/20DB LIN-DB
S 1	25101271A	SWC 3056A RANGE REP251C0801E	50423	
S 10	25077860A	SWC LINE VOLTAGE-SLIDE	82389	SWITCHCRAFT #46256LF

REAR PANEL (3056A)

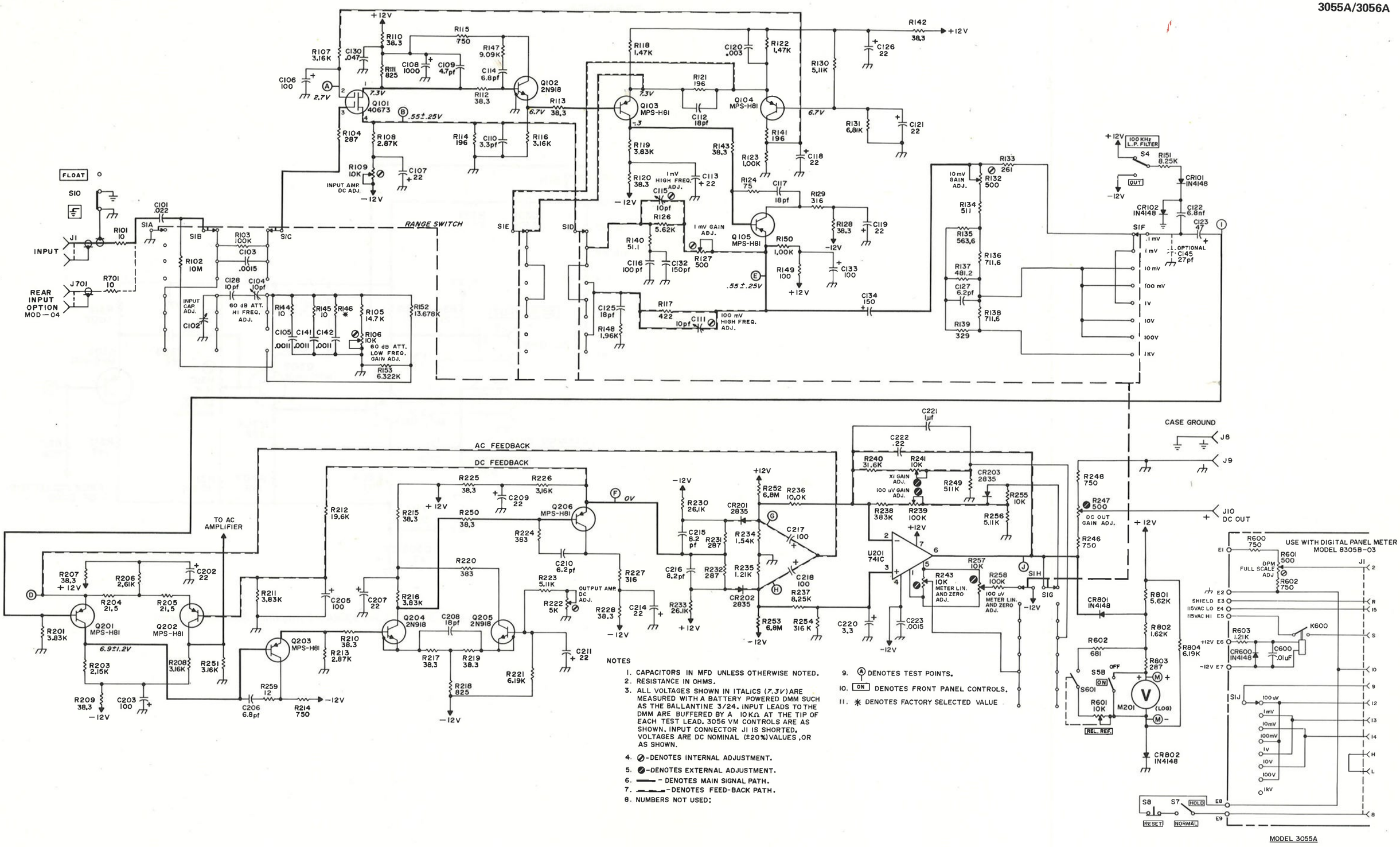
SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
---	89101971A	REAR PANEL ASSY	50423	
C 1A	17100000A	FLE POWERLINE FILTER 250V	50423	F1740-410581 E.RODERSTEIN
C 1B	17100000A	FLE POWERLINE FILTER 250V	50423	F1740-410581 E.RODERSTEIN
F 1	19034100A	FUS 0.4 AMP. TYPE MDL	71400	BUSSMANN SLO-BLOW
J 2	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
J 3	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
J 5	31100000A	REC AC POWER	82389	SWITCHCRAFT
J 6	31073290A	BPS BINDING, NYLON, BLK.	83330	H.H.SMITH #1517
J 7	31082120A	BPS #1517, NYLON,WHITE	83330	H.H.SMITH
J 8	31100770A	BPS GND	83330	HH.SMITH 1518
J 9	31073290A	BPS BINDING, NYLON, BLK.	83330	H.H.SMITH #1517
J 10	31082020A	BPS #1517 RED	83330	H.H.SMITH
R 1	12127330A	RFC 22.0 2.0 W K+-10%	01121	A-B TYP HB OR EQUIV

REAR PANEL (3056A) — Continued

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
		OPTION 04 ALSO INCLUDES:		
J 701	31033790A	CON UG-1094/U BNC,DAGE	29587	STATE ELECT.PARTS
R 701	12121000A	RFF 10.0 500 MW F+-1%	16299	CGW RN60D 10R0 F
		OPTION 05 ALSO INCLUDES:		
---	35100381F	BKT 3045A BAT SUP	50423	
---	85100390A	BAT 28.8 V .6AMP-HRS	24446	GE PPS 2178 7325

MISCELLANEOUS (3056A)

SCHEMATIC REF	BALLANTINE PART NO.	DESCRIPTION	MFR CODE	MFR PART NUMBER
---	19100140A	FSH SQUARE MOLDED GRAY	75915	LITTLEFUSE 348-8-9-9
---	31100940A	CAP C&K RED FOR STD TOGGLE	09353	C&K A7062-3
---	31100960A	CAP C&K BLUE FOR STD TOGGLE	09353	C&K A7062-7
---	33100000A	LNC LINE CORD SET 7FT.MLD	70903	BELDEN CORD SET 8N772
---	37100121L	PLT DECORATIVE SIDE STRIP	50423	
---	40100020A	PNT 10MM BLACK	50423	
---	40100040A	CAK 10MM BLACK	50423	
---	40100100A	KNB 10MM BLK 4MM SHAFT	50423	
---	40100160A	KNB 21 MM BLK 1/4 SHAFT	50423	
---	40100240A	CAK 21MM BLK CAP	50423	
---	44087880A	ASY BALL & FOOT ASY. 6.6 IN	21604	BUCKEYE MP 40008-11
---	51100591L	COV 3045 SERIES BOT. BROWN	50423	
---	51100601L	COV 3045 SERIES TOP BROWN	50423	



NOTES

1. CAPACITORS IN MFD UNLESS OTHERWISE NOTED.
2. RESISTANCE IN OHMS.
3. ALL VOLTAGES SHOWN IN ITALICS (*7.3V*) ARE MEASURED WITH A BATTERY POWERED DMM SUCH AS THE BALLANTINE 3/24. INPUT LEADS TO THE DMM ARE BUFFERED BY A 10KΩ AT THE TIP OF EACH TEST LEAD. 3056 VM CONTROLS ARE AS SHOWN. INPUT CONNECTOR J1 IS SHORTED. VOLTAGES ARE DC NOMINAL (±20%) VALUES, OR AS SHOWN.
4. ⊘ - DENOTES INTERNAL ADJUSTMENT.
5. ⊘ - DENOTES EXTERNAL ADJUSTMENT.
6. ——— - DENOTES MAIN SIGNAL PATH.
7. — — — - DENOTES FEED-BACK PATH.
8. NUMBERS NOT USED.
9. Ⓐ DENOTES TEST POINTS.
10. [ON] DENOTES FRONT PANEL CONTROLS.
11. ✳ DENOTES FACTORY SELECTED VALUE

Figure 6–1. 3055A and 3056A Schematic Diagram

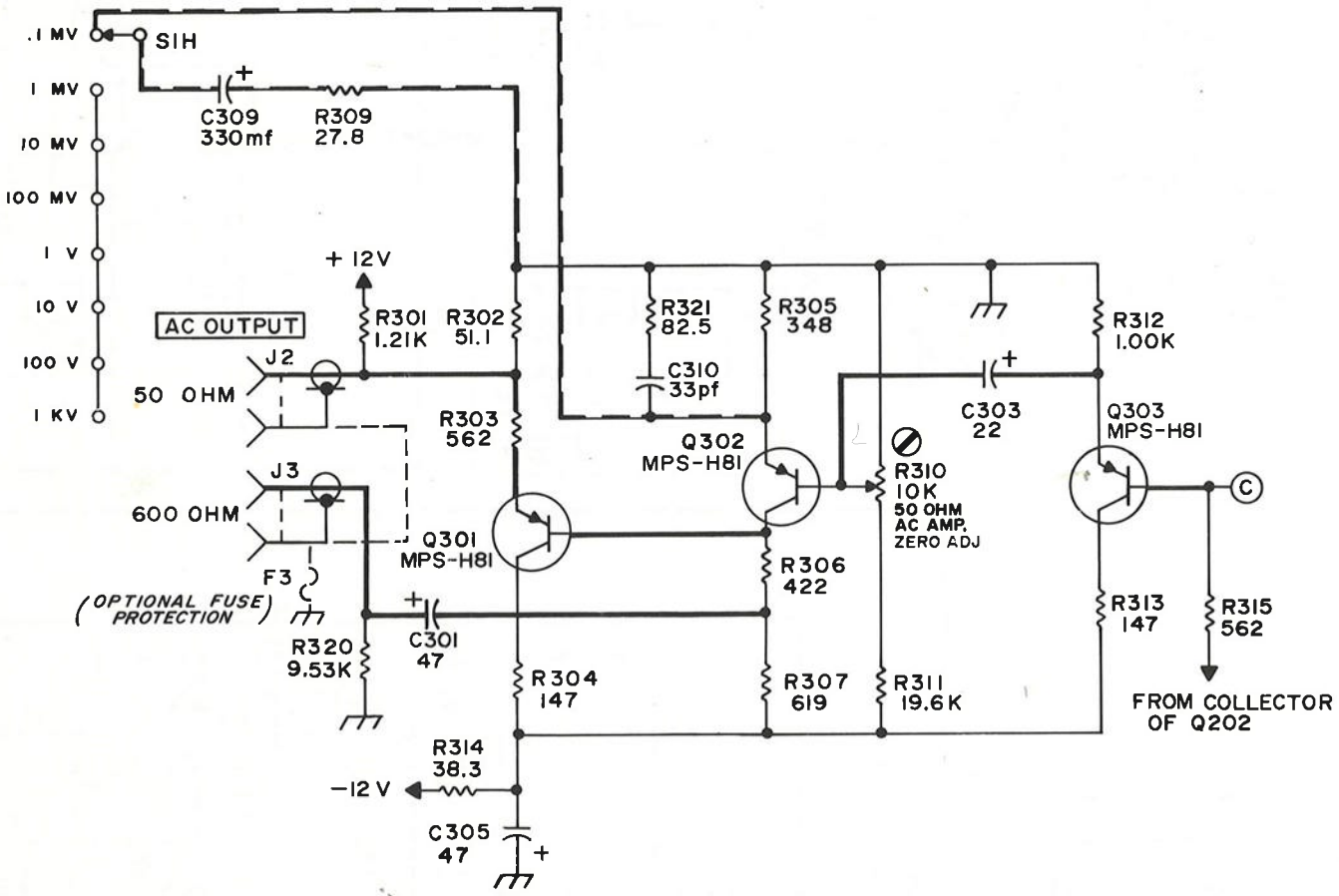


Figure 6–2. 3055A and 3056A AC Amplifier, Schematic Diagram

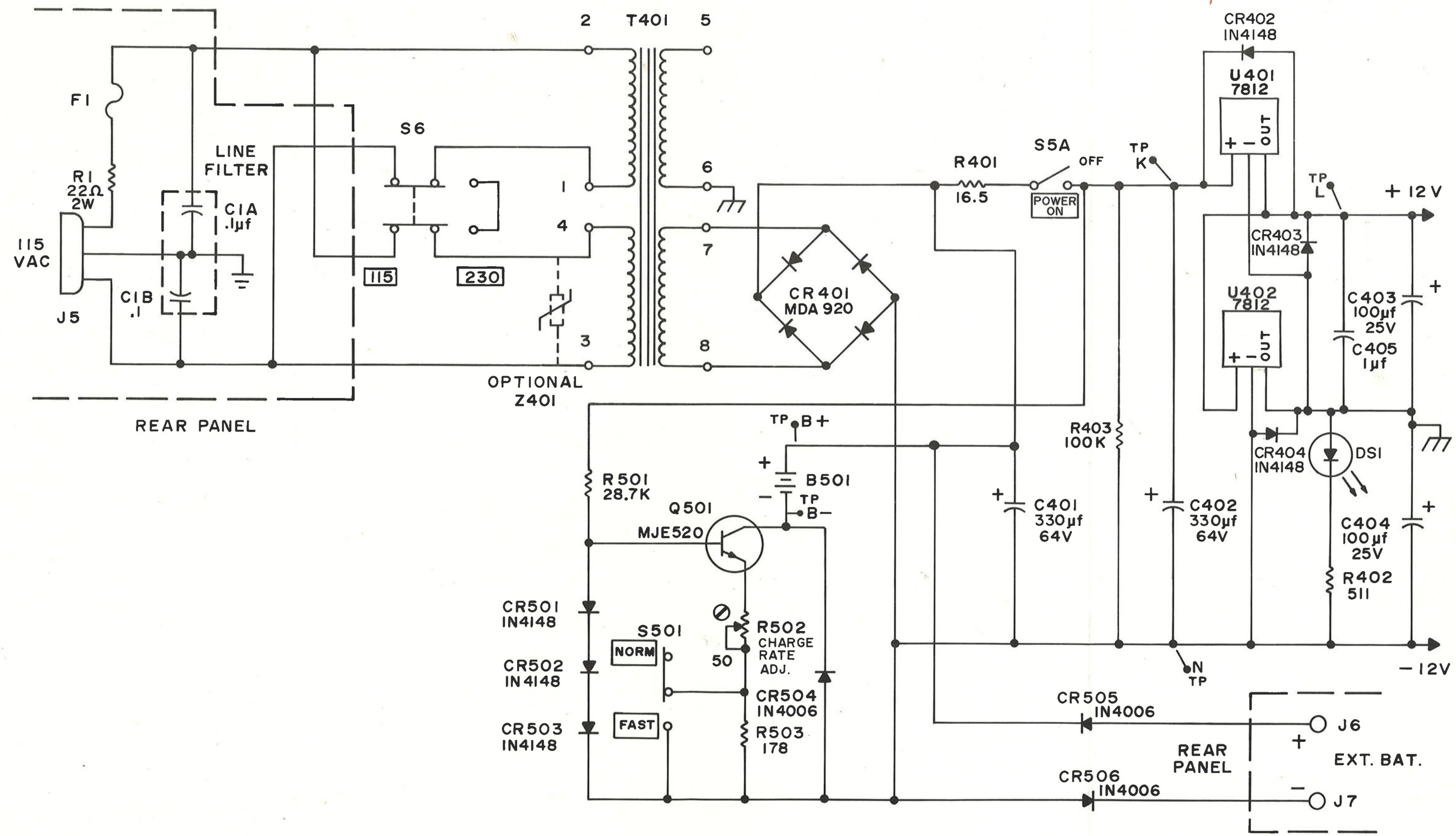


Figure 6--3. 3055A and 3056A Power Supply, Schematic Diagram

Ballantine Laboratories, Inc.
P.O. Box 97, Boonton, New Jersey 07005, U.S.A.
Telephone: 201-335-0900, TWX: 710-987-8380